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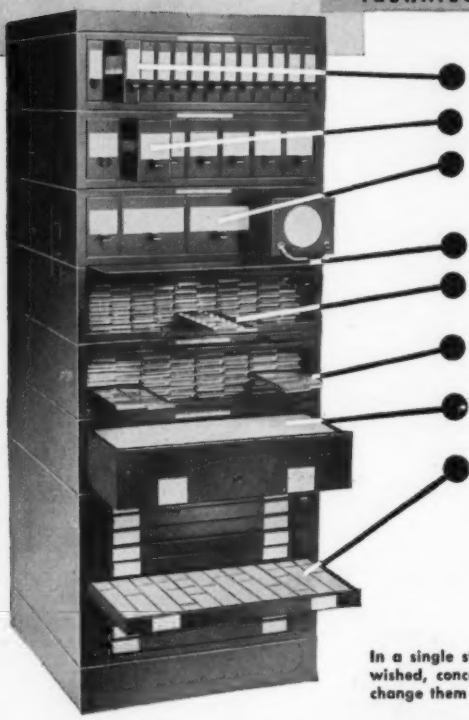

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Cancer Research

CANCER is the most difficult research problem man has ever attempted to solve. An early attack on the problem began with the founding of The American Association for Cancer Research in 1907. Previously, to be sure, medical authorities had recognized the great *clinical* problems presented by cancer. But not until 1907 did interest in cancer *research* crystallize sufficiently to bring together a group of cancer specialists, for the purpose of discussing their observations and formulating a research attack. In its early years the association was small, and an annual meeting proved adequate for the communication of results and ideas among members. Today, The American Association for Cancer Research has nearly a thousand members and publishes the monthly journal *Cancer Research,* in addition to continuing its meetings.

In the early days of cancer research a few scattered investigators carried on despite chronic lack of funds. The public attitude toward cancer at that time was a serious difficulty. In fact, up to a few years ago, even the best educated people were reluctant to admit that a close relative had died of cancer. This stigma hampered the flow of funds into cancer research. Hence, as a rule, only investigators with private means dared enter this field. Although the National Cancer Institute was established by Congress in 1937, it received an average annual appropriation of only half a million dollars during its first decade. And this money was for all cancer activities, not just for research.

Today the picture is entirely different. The public has become well aware of cancer and its problems, in part through mounting cancer mortality. But an even more potent factor in stimulating public awareness has been the annual, nationwide crusade, initiated by the American Cancer Society in 1945. This month-long effort combines an educational drive with a fund-raising campaign. The educational aspect lays heavy emphasis upon the vital role of research in the ultimate control of cancer. At the same time substantial financial support for cancer research is obtained. At the beginning of the cancer crusade, the board of directors of the American Cancer Society voted to allocate to research at least 25 per cent of all money collected. Currently this research allocation amounts to some $4,000,000 annually; since 1945 the total has been over $20,000,000!

The society does not itself conduct laboratory or clinical research. The research funds it raises are, rather, granted as fellowships and scholarships for research training, as grants-in-aid supporting specific projects, and as institutional research grants. The latter grants—which the society pioneered—support broad, integrated cancer research programs, rather than projects.

Recommendations on awards of American Cancer Society fellowships, scholarships, and grants-in-aid, as well as scientific assistance and advice, are provided by the Committee on Growth of the National Research Council. This committee was created for such purposes in 1945, by contract between the society and the National Academy of Sciences. It functions through panels, each covering one of the disciplines, totaling upwards of a dozen, that comprise modern cancer research.

That is the cancer research problem and what has been done about it so far. What still needs to be done? Successful prosecution of cancer research demands sacrifices by the public and by scientists. The public must pay the bills, through tax support of Congressional appropriations and through voluntary contributions. Scientists must carry out the research, thereby perhaps foregoing material advantages to be found in other careers. Their compensation will be the satisfaction of participating in a program aimed toward ultimate eradication of one of the worst human scourges of all time.

J. EDWARD SPIKE, JR.
Research Committee, American Cancer Society, Inc.
New York

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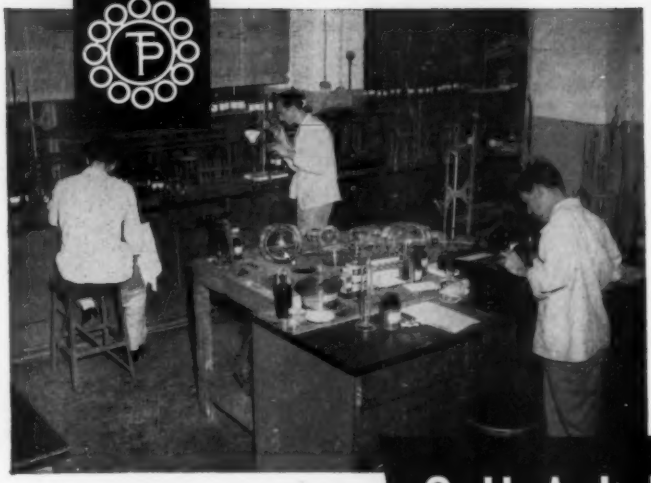

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Optimum Location of a Photoelectric Observatory[1]

John B. Irwin

Goethe Link Observatory, Indiana University, Bloomington

ALTHOUGH IT HAS BEEN MORE THAN FIVE YEARS since Kron (*1*) at the Lick Observatory demonstrated the astronomical possibilities of the multiplier phototube, little attention has been paid to the unique observing needs for research with this instrument. It has been expedient to adapt existing telescopes and sites, far better suited to astrometry and spectroscopy, to photoelectric photometry. Recent results, however, have been so successful, and new techniques have developed so rapidly, that it is surely not unreasonable at this time to consider the establishment of an observatory with telescopic equipment designed, and at a site chosen expressly, for the peculiar needs of photoelectric astronomy.

The photoelectric cell had always been a precision device for those astronomical objects that were bright enough; the modern multiplier phototube extended the faint limit to such a point that measurements in two colors were possible—with fair precision—for stars that were just visible in the eyepiece of the telescope. The photoelectric results of the past five years have verged on the spectacular. One might mention the startling discovery of interstellar polarization (*2, 3*), the puzzling relationship between color and distance for extragalactic nebulae (*4*), and the extension of fundamental magnitude and color sequences to fainter than nineteenth photographic magnitude (*5*)—sequences that will help to form the fundamental basis for any new cosmology. Furthermore, Hiltner has just announced (*6*) an increase in accuracy of a factor of more than ten in the determination of the degree of polarization of the light of bright stars; his ingenious instrumentation undoubtedly has opened up a completely new field of photoelectric investigation.

It is not, however, the purpose of this paper to dwell either on past successes or to predict the probable course of photoelectric investigations and discoveries in the near future. Rather, it is to inquire into the observational needs of the photoelectric observer, in order that his investigations may be pursued with maximum efficiency both as to quality and quantity. The viewpoint here is somewhat different from that usually taken. In general, one does as best one can with the available telescopic equipment, even though the telescope in question may be partially unsuitable, too small, poorly driven, and located amid city lights and haze or in an unsuitable climate.

It is recognized that the observational needs differ in astrometry, spectroscopy, and photometry. The positional astronomer is primarily interested in good seeing; haze or very thin clouds, rather than being objectionable, may be indicative of a very steady atmosphere and, therefore, of a first-class night. City lights, in moderation, are only a secondary nuisance. The spectroscopist, on the other hand, can work to advantage on nights that would be hopeless from the point of view of the astrometrist; that is, on nights of poor seeing. The quality of a spectrogram, except in special cases such as Sirius B or Antares B, is affected only to a minor extent by poor seeing, occasional clouds, haze, or, in the case of moderate to high dispersion work, by moonlight. One who has watched the McDonald observers at work in a moonlit sky half full of cumulus clouds can only marvel at how their persistence pays off in useful results. And yet, despite these less rigid requirements, and with all due respect to much excellent spectroscopic work accomplished in the Middle West and East, there is no question but that the great bulk of our spectroscopic research has been—and is being—accomplished at the Texas and Pacific Coast observatories, where observing conditions are notably superior. Only one type of astronomical spectroscopy—namely, objective-prism spectroscopy—has been pursued with outstanding success in the otherwise unsuitable climates of the Harvard, Leander McCormick, and Warner and Swasey observatories. This is probably due to the fact that in this type of work little telescope time is required for rather extensive investigations.

The astronomical photometrist requires, above all else, a clear sky; this is especially true because his results may be discussed in terms of thousandths of a magnitude. One might ask: "How clear a sky?" The answer is: "Just as clear as possible—*the best is none too good.*" The photocell can "see" and respond to thin cirrus clouds long before they become apparent to the naked eye. Such clouds are worse than a nuisance; once they have intruded themselves into the observations their effects are subtly injurious to the scientific interpretation and are difficult to eradicate. At the Goethe Link Observatory we call such clouds "photoelectric poison." Another photoelectric requirement, one that is probably almost as important, is that the atmosphere be uniformly transparent

[1] Based on an address given before the Neighborhood Astronomers, Ohio University, Athens, October 13, 1951.

over the whole sky and over long periods of time. This is necessary especially in the case of the determination of fundamental colors and magnitudes, where zero points must be repeatedly transferred over large angular distances and where a knowledge of the extinction coefficient, and its possible variation, is of the utmost importance. Unlike spectroscopy, partial runs are not only frustrating to the observer, but are often practically useless in the case of variable stars. They may be even worse than useless with the probability of dubious observations at the beginning or end of such runs.

To fix ideas, let us consider possible photoelectric observations of an eclipsing star with a period of five days. Satisfactory observations of primary minimum can be made only at minima occurring, say, within three hours of meridian passage—that is, only one out of four such minima on the average. If the star is too faint at such times to "put up" with a moonlit sky, this reduces to one out of eight minima; if the climate is such that the odds are two to one against the observer having clear skies, then he may expect, on the average, a satisfactory run every one hundred and twenty days; that is, once in an observing season, or year! And yet, it is this type of observation, repeated year after year, that affords the only direct approach to the knowledge of the internal density distribution of stars—one of the most important problems in stellar structure.

It is becoming increasingly clear that a sustained attack on this problem must be made photoelectrically, rather than photographically. Variation of period as determined from primary minima alone is complicated by effects due to the possible presence of a third or fourth component, by little-understood irregular changes in period, and so on. The phenomenon one seeks to evaluate is the rotation of the line of apsides, which only betrays itself unmistakably by the changing position of shallow secondary minima with respect to primary minima. This may seem like a dull and long-winded program—yet such may not be the case. The greatest known variation of period of any eclipsing star is that of SV Centauri (*7, 8*); nonetheless this variation is completely unexplainable under any reasonable set of assumptions. Eggen's results for Algol (*9*), derived from the complicated variation of period combined with six-color photometry of this famous eclipsing star, are also rather strange and unsatisfactory. Perhaps we are faced with some completely new astrophysical phenomenon. In any event, little or nothing is known of possible rapid changes of period of eclipsing stars.

It might be supposed that good seeing would be of primary importance in the best photoelectric work; this is probably not so, except for those observations where the amount of night-sky light (admitted with the starlight through a small diaphragm) must be kept to a minimum. This would be the case for measurements made on the very faintest objects, moderately faint objects in a moonlit sky, visual binaries, and very rich star fields. My own experience in South Africa (*10*), where the seeing at times was extraordinarily poor, indicated rather strongly that excellent results could be obtained at such times by merely increasing the size of the diaphragm by a factor of two. This might not be the case for small-aperture telescopes, inasmuch as Stebbins (*11*) has shown that photoelectric seeing varies markedly with the size of the objective.

If one is willing to admit that seeing is of secondary importance, then the whole problem of seeking the ideal photoelectric site in this country becomes very much simpler: One needs, at first, only to look for moderately high mountains located in a region of minimum cloudiness. Such a region in this country is apparent at the first glance at the appropriate Department of Agriculture map (*12*). A modification of this map is given in Fig 1. The region in question is centered almost exactly on Yuma, Arizona, and is roughly elliptical in shape, extending about 80 miles north-northwest of Yuma and about 40 miles to the east and to the west of that city. Within this region there are more than 300 clear days a year; outside this region and the surrounding area there is no spot in the country where there are as many as 240 clear days a year on the average (these data are based on 20-year statistics). Unfortunately, there are no peaks as high as 5000 feet in this area, the highest being Black Butte (alt, 4505 ft), 42 miles west of Blythe, California. Other mountains include Castle Dome Peak (alt, 3793 ft), 38 miles northeast of Yuma, and Sheep Mountain (alt, 3150 ft), 26 miles east-southeast of Yuma. There are other peaks within this region just over 3000 feet in altitude. In general, one would not like to locate a photoelectric station at an altitude much under 4500 feet, although Castle Dome Peak and Sheep Mountain might be seriously investigated in more detail. It is a question not so much of getting above as much of the earth's atmosphere as possible, inasmuch as every 1000 feet gained in elevation means a reduction of only 3 per cent in the value of the atmospheric extinction coefficient, but rather of getting above the haze and dust level that might be seriously high during the critical summer months.

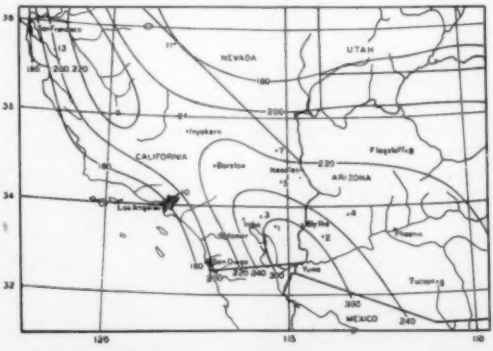

FIG. 1. Average number of clear days a year, adapted from USDA data. Numbered sites refer to stations listed in Table 1.

Two higher peaks are to be found just outside the optimum region. Signal Peak (alt, 4828 ft) is 55 miles northeast of Yuma; Eagle Mountain (alt, 5347 ft) is 25 miles east of Indio, California. Other desert peaks that might be considered include Harquahala Peak (alt, 5672 ft), 72 miles east-northeast of Blythe; Old Woman Mountain (alt, 5300 ft), 40 miles southwest of Needles, California; New York Peak (alt, 7445 ft), 50 miles northwest of Needles; Cactus Peak (alt, 5415 ft), 25 miles north of Inyokern, California; and White Mountain Peak (alt, 14,256 ft), 10 miles west of the California-Nevada border and about 10 miles south of the latitude of San Francisco. Clear day (per year) data and percentage sunshine data (for each season and measured in terms of the ratio of total sunshine to total possible sunshine) for these peaks and for certain other observatory locations have been interpolated from the appropriate Department of Agriculture maps (*12, 13*) and are given in Table 1. One can think of reasons why these data may be systematically wrong by small amounts, especially for the tops of mountain peaks, inasmuch as they have been "smoothed," and local irregularities have probably been ignored; furthermore, the original observations, for the most part, were taken at lower altitudes.

TABLE 1*

Station	Av no. clear days	Percentage sunshine of possible total					Estimated photoelectric nights (%)
		Winter	Spring	Summer	Fall	Av	
Black Butte	310	82	92	95	90	89.8	79
Signal Peak	280	83	91	94	96	91.0	75
Eagle Mountain	285	80	90	92	90	88.0	73
Harquahala Peak	235	79	87	91	91	87.0	63
Old Woman Mountain	230	80	86	93	91	87.5	63
Tucson, Ariz.	230	78	88	88	91	86.2	61
New York Peak	215	74	81	90	84	82.2	55
Flagstaff, Ariz.	215	73	77	86	84	80.0	52
Cactus Peak	205	68	79	93	84	81.0	52
Mount Wilson	195	65	70	79	80	73.5	42
White Mountain Peak	180	60	76	87	78	75.2	41
McDonald Observatory	175	61	70	76	78	71.2	36
Lick Observatory	200	46	70	74	70	65.0	34
Goethe Link Observatory	120	42	58	70	61	57.8	12
Boston, Mass.	120	48	62	62	52	56.0	10

* Stations should be numbered in sequence from 1 to 15 to correspond with numbers in Fig. 1.

The *relative* cloudiness of the different sites should be approximately correct. In terms of "photoelectric" nights—entire nights without a trace of a cloud—the numbers and percentages are both almost certainly too optimistic—by different amounts. Somewhat arbitrary corrections must, therefore, be applied to the data. A mean for each station was computed as follows: the number of nonclear days for each station was multiplied by a factor of 1.3, and the product subtracted from 365. This result, when divided by 365 and expressed as percentage, was given equal weight with the result obtained by multiplying the nonsunshine percentage by a factor of 2.1 and subtracting the product from 100 per cent. These mean percentages are given in the last column of Table 1 and are the estimated percentages of "photoelectric" nights that might be expected at each station. They were computed in such a way as to agree with various independent estimates of photoelectric conditions at the McDonald and Goethe Link observatories. The main result of this analysis is to show that the desert peaks in southeastern California and southwestern Arizona near Yuma *are probably almost a factor of two better for photoelectric research* than other large existing American observatory sites. This is in terms of quantity; in terms of percentage of satisfactorily completed programs—especially observational programs by guest investigators—the factor would almost certainly be somewhat larger.

This analysis, of necessity, omits such important items as "smog" and city lights, currently available instruments, photoelectric "know-how," and past achievements in this field. More detailed investigations as to haze conditions might possibly change the above conclusion. My own experience at Cactus Peak during the summers of 1948 and 1949 indicated that the haze was negligible and that the atmospheric transparency could only be described as superb. Other preliminary investigations might include the analysis of airways meteorological statistics, the seeing and transparency, and questions of power, telephone, water, roads, availability of land, etc. The desert is not usually thought to be an ideal place to live and work; and yet, with the amenities of air-conditioned houses, water and electricity, good highways, refrigerators, and radios, it can be both comfortable and satisfying. The University of Chicago astronomers have shown how an observatory in a rather remote section of the country can be efficiently operated from a very considerable distance. There is no reason to think that their techniques cannot be duplicated.

A few remarks on possible equipment for our suggested photoelectric observatory might be in order. Inasmuch as the cost of a telescope goes up something as the cube of its size, and because the vast majority of the countless photoelectric problems can be attacked with instruments of small or moderate size, it would seem profitable to have a number of small reflectors, rather than a single large one. One 12-inch and two 36-inch reflectors might be one solution. The small instrument would be useful not only in keeping track of the atmospheric extinction, but also in a variety of programs dealing with the brighter stars. One of the larger instruments might be devoted to long-range programs, and the other could concentrate on numerous special investigations. The telescopes should be reflectors (because of their perfect achromatism) and should be of the "light-bucket" type—that is, a short focal length mirror in combination with a special

Cassegrain secondary mirror. This would minimize the size of the telescope—and hence the expense—as well as make it easier to handle. Such a design is already in existence. The optics, mounting, and driving mechanism should all be of the finest construction so that very small diaphragms might be safely used.

If such an observatory were to be established, there is no question but that it would make a very substantial contribution to our astrophysical knowledge at a fraction of the initial cost of a very large reflector. It would also provide a real opportunity for guest investigators from the Middle West and the East, who are seriously handicapped at present by their climate and often by city lights. "Home" researches in objective-prism spectroscopy and photographic photometry would be greatly strengthened by additional photoelectric observations. Serious photoelectric work is being accomplished or contemplated at many observatories in the eastern half of this country, including Harvard, Princeton, Pennsylvania, U. S. Naval Observatory, Virginia, Case, Ohio State, Michigan, Vanderbilt, Wisconsin, and Indiana. Such work is invaluable both in the training of graduate students and in the development of photoelectric equipment and experience. All these observatories—and others—should be intensely interested in the establishment of a permanent desert observatory devoted to photoelectric research. Here, then, is a superb opportunity which, if brought to fruition, would make possible an ever-continuing series of important investigations pursued under optimum conditions.

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Application of Echo-Ranging Techniques to the Determination of Structure of Biological Tissues[1]

John J. Wild and John M. Reid[2, 3]

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THE RESULTS OF PRELIMINARY STUDIES on the use of a narrow beam of 15 megacycle pulsed ultrasonic energy for the examination of the histological structure of tissues have been sufficiently encouraging to warrant the development of the apparatus that is the subject of this report.

Whereas the initial method of examination of tissues gave records of histological structure in one dimension analogous to a needle biopsy, the method to be described was designed to give a two-dimensional picture such as would be obtained by adding up the information from a series of needle biopsies taken in one plane across a given piece of tissue. Such differentiation of soft tissue structure is without precedent in the biological field. Theoretically it was thought possible to record soft tissue structure by tracing the information obtained from a sound beam sweeping through the tissues onto a fluorescent television screen. Thus, a tumor could be detected in soft tissues, provided the echoes returning from the tumor differed from the echoes returning from the tissue of origin of the tumor. Differences of sufficient magnitude obtained from the needle biopsy method of examination have already been demonstrated in the pilot studies reported elsewhere (*1–4*). The initial studies covered a variety of common tumors arising in the human stomach, brain, and breast. Work subsequent to these studies has confirmed the findings on a larger and wider scale.

Definition of terms. It is necessary to introduce some new words in order to make it possible to describe the

[1] This investigation was supported by a research grant from the National Cancer Institute of the National Institutes of Health, USPHS.

[2] We wish to thank Maurice B. Visscher, head of the Department of Physiology, and Henry E. Hartig, head of the Department of Electrical Engineering, University of Minnesota, for their help and suggestions in the preparation of this communication, particularly in regard to the section on terminology.

[3] Formerly of the Department of Surgery, University of Minnesota Medical School, Minneapolis.

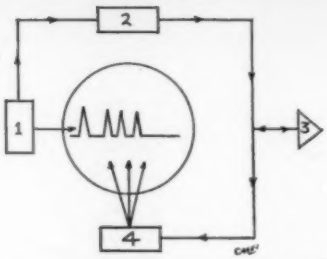

FIG. 1. Arrangement of the basic echographic system.

following material. Accordingly, the whole subject of examination of biological tissues by means of ultrasonic echo returns will be referred to as "Echography," corresponding with the term "electrocardiography." Similarly, the apparatus associated with production of the records will be referred to as an "Echograph." It is the basic machine used for both unidimensional and two-dimensional echography. The applicator units will be referred to as unidimensional "Echoscopes" and two-dimensional echoscopes. The records obtained will be referred to as unidimensional "Echograms" and two-dimensional echograms.

Unidimensional echography. To understand two-dimensional echography, or the moving sound beam method of tracing out the histological structure of biological tissues, it is necessary to review briefly unidimensional echography, or the stationary beam method of examination.

The basic principle of the echograph is the driving of bursts of sound energy into tissues. Sound travels through tissues as pressure waves, so that the effects are entirely mechanical. If the power of the pressure waves and the period of application are kept low, no damage results (*5*). In between the bursts of sound energy, which are generated by a piezoelectric crystal, or transducer, echoes returning from the tissues strike the same crystal, and electric charges are generated. These charges are amplified greatly and are made to modify a beam of electrons sweeping back and forth on the face of a television screen at such a rate as to take advantage of persistence of vision. A static trace is thus produced that can be observed with the naked eye and photographed for permanent recording.

The echograph. The arrangement of the components of the electronic system is shown in Fig. 1. An electronic clock (1) times the bursts of sound energy and starts the trace on the face of the television screen (cathode-ray tube). The transmitter (2), upon receipt of the pulse from (1), creates the electrical impulses necessary to cause the piezoelectric crystal (3) to vibrate. The sound leaves the crystal in a narrow beam and penetrates the tissues. Echoes returning from the tissues are received by the same crystal (3), now quiescent, and are amplified by unit (4) to deflect the trace as shown. The process is repeated often enough to give a stable trace that can be observed and photographed.

In practice it has been found possible to use a self-contained instrument, called a unidimensional echoscope (Fig. 2, top), which provides hydraulic coupling between the crystal, or transducer, and the pieces of tissue under examination. A column of water is placed between the transducer and a wetted rubber membrane, which seals the unit. The sound energy passes in a narrow beam through the water, the wetted rubber membrane, and the tissue, and the echoes are returned. The unidimensional echogram obtained is also shown in Fig. 2 (bottom). A_1 is the transmitted pulse sent out by unit (2) in Fig. 1, which is amplified by unit (4) in the same manner as an echo. B_1 is the echo returned from the rubber-membrane-tissue interface B. C_1 is the corresponding echo returned from the tissue-air interface C. In between B_1 and C_1 can be seen echoes arising from within the tissue.

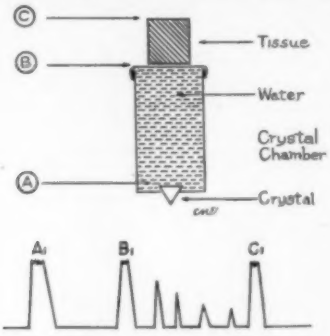

FIG. 2. Cross section of crystal chamber and tissue under examination (top) and a typical unidimensional echogram obtained from the arrangement (bottom).

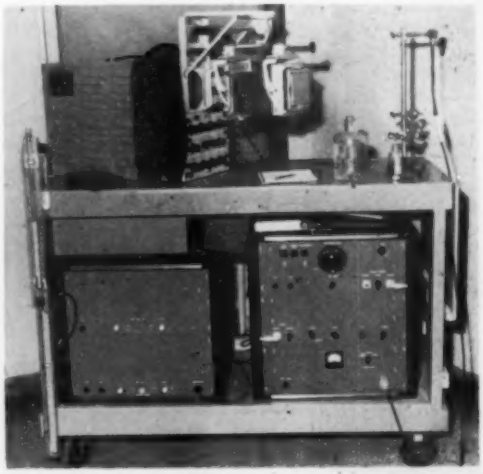

FIG. 3. The complete echographic apparatus as used in hospital. The unidimensional echoscope can be seen clamped to a stand on the right, connected to the transmitter-receiver unit. The cathode-ray screen with the camera in the recording position is to the left on the table.

It should be noted that the strength (loudness) of the echoes is recorded vertically, and the time of occurrence, or depth, of propagation of the echoes in the tissue is recorded horizontally. The part of the trace between A_1 and B_1 is constant and is deleted from the actual presentations in order to use the available space on the television screen to the fullest advantage. (Reference to *D* in Fig. 7 will show a photographic record of the trace obtained from a piece of normal beef kidney cortex in the manner described here. *X* and *Y* correspond to B_1 and C_1 in Fig. 2.)

A photograph of the echograph as used in hospital for cancer detection studies is shown in Fig. 3. The unidimensional echoscope shown in Fig. 2 can be held in the hand and applied to the tissues under examination.

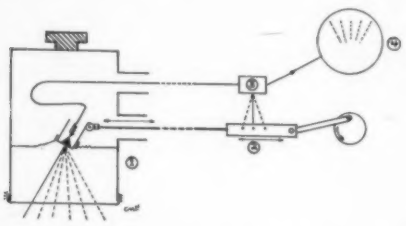

FIG. 4. Diagram illustrating the principle of operation of the two-dimensional echographic modification. The pivoted crystal mounted in the two-dimensional echoscope (1) is driven by the oscillating ram (2), which is connected mechanically to the electronic unit (3), which synchronizes the position of the sweep on the cathode-ray screen (4) with the path of the sound beam in the tissues.

Clinical studies on the living, intact subject indicated that a two-dimensional method of presentation would give additional information, greatly facilitating the interpretation of the unidimensional echograms. The type of record described in Fig. 2 is, in effect, the equivalent of a needle biopsy in that the path of the narrow beam of sound penetrating the tissues does not move for a given record. If a series of such unidimensional echograms could be taken in one plane over an area of skin, a graph could theoretically be made from the echograms, and a structure such as a tumor could be delineated and located in depth, or detected in two dimensions. Practically, such a procedure would be extremely difficult. Fortunately, the same result can be obtained automatically by applying the principles of echo-ranging. A pilot model was fabricated for attachment to the basic echograph so that a rapid change-over could be effected when necessary.

Two-dimensional echography. A functional diagram of the mechanism is shown in Fig. 4. The two-dimensional echoscope (1) containing the crystal mounted on pivots can be seen. (The actual instrument is shown in Fig. 5.) The pivoted crystal is mounted in a water chamber closed by a rubber membrane. As the crystal is moved through an angle of 45 degrees, an area of skin together with the underlying tissue is swept by the sound beam in one plane. The movement of the

FIG. 5. The two-dimensional echoscope as used in the experiments. The flexible mechanical and electrical connections can be seen.

crystal is synchronized by means of an oscillating ram (2) connected flexibly and mechanically to the crystal and electronically through unit (3) to the television or cathode-ray screen (4). The complete two-dimensional echographic conversion unit is shown in Fig. 6.[4]

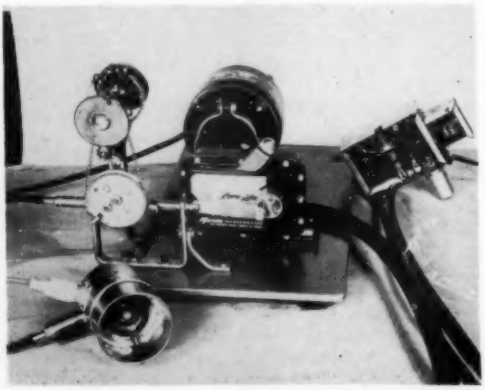

FIG. 6. The units for two-dimensional echographic conversion. Grouped about the oscillating ram, which is driven by a variable speed drive, are the echoscope (left foreground) and the plug-in electronic conversion box (right).

Experiments. To orientate two-dimensional echography with unidimensional echography, a piece of beef kidney cortex approximately 1 cm thick was cut. This specimen was laid upon the wetted rubber membrane of the two-dimensional echoscope at *C* (Fig. 7), in the same manner as in Fig. 2. It will be noted that the specimen was thinner in the center than at the end of the range of travel of the sound beam, indicated by the broken lines. It will also be noted that the specimen was placed upon the membrane in such a manner that at one extreme of travel of the crystal the sound beam would pass into air. The crystal was

[4] We wish to thank Revco, Incorporated, 405 Thorpe Building, Minneapolis, for supplying the widely variable gearbox shown in Fig. 6.

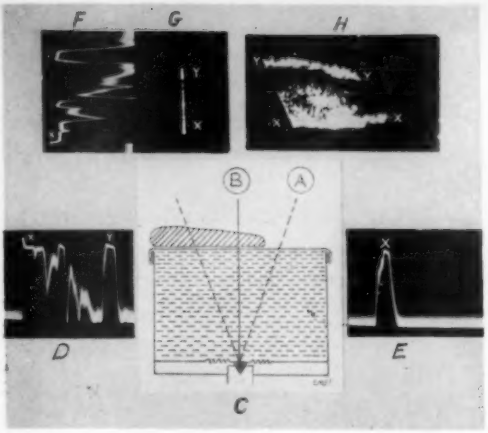

FIG. 7. At *C*, a cross section of two-dimensional echoscope set up for kidney cortex experiment. (Cf. Fig. 2, top.) At *E*, the unidimensional echogram of the membrane-air interface *X*; at *D*, echoes returned from the kidney cortex tissue between the rubber membrane signal *X* and the tissue-air leaving interface *Y*; at *F*, the echogram *D* oriented vertically; at *G*, an alternative method of presentation of echogram *D* obtained by variation of intensity. The time axis is vertical in both traces. Variations in the strength of echoes can be seen between *X* and *Y* as deflections of the baseline in trace *F* and as areas of differing intensity in the trace *G*. At *H*, the two-dimensional echogram obtained by sweeping the unidimensional echogram *G*. The outline of the tissue can be seen "painted out" by the tissue-air leaving interface *Y*. The membrane signal *X* can be discerned at the bottom of the record. It can be seen from *H* that the kidney did not extend completely across the applicator.

locked in position pointing in the direction A so that the sound beam passed into air after leaving the rubber membrane. The unidimensional echogram *E* was obtained. It will be observed that the rubber-membrane-air interface returned a strong echo *X* and that no echoes returned from the air beyond the rubber membrane in the path of the sound beam.

Next the crystal was rotated so that the sound beam traveled in the direction *B* through the tissue, in a manner analogous to the arrangement shown in Fig. 2. The crystal was locked in this position, and the unidimensional echogram shown at *D* was obtained. Again the rubber-membrane-tissue interface returned a strong echo *X*, as did the tissue-air interface *Y*. In between *X* and *Y* can be seen echoes arising from within the kidney substance. In the echogram *D* the time base for the returning echoes runs from left to right horizontally. This means that the echoes returning from the rubber-membrane-tissue interface *X* appear sooner on the record than the echoes returning from beyond the rubber-membrane-air interface, because of the delay of sound in the tissue as greater depth of tissue is penetrated. The strength of the returning echoes is shown by the vertical deflections from the base line.

To facilitate understanding the next step, the unidimensional echogram *D* is turned 90 degrees, and the time base is now oriented from below up, as shown at *F*.

The next step is to present the echoes shown on the unidimensional echogram *F* (and *D*) as spots of varying intensity on the face of the television screen. Thus, the strong rubber-membrane-tissue interface echo *X* can be seen at the lower part of the unidimensional echogram *G*, and the strong tissue-air interface *Y*, at the top. In between are spots of light the brightness of which varies according to the strength of the echoes returning from the kidney tissue with the crystal locked in position *B* of Fig. 7, at *C*.

The echogram shown at *G* was then caused to move in synchronism with the pivoted crystal, as shown in Fig. 4 (1 and 4). As the unidimensional echogram *G* moved in its sector, lines were traced out by the spots of light on the cathode-ray screen. A photographic plate was exposed during this process. The internal structure of the kidney based on echoes from within the kidney substance was traced out as the sound beam swept in and out of the tissue.

The record shown at *H* is believed to be the first two-dimensional echogram of biological tissue to be recorded. The varying thickness of the specimen can be seen as the tissue-air interface *Y–Y* was traced out on the photographic film. The rubber-membrane-tissue

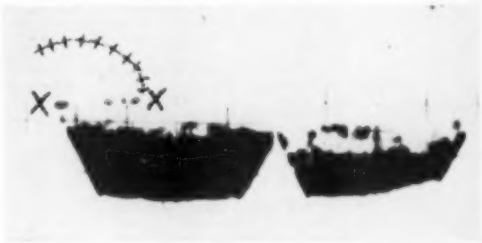

FIG. 8. The two-dimensional echogram obtained from a patient with a tumor of the adductor muscles of the left thigh above the knee. The right-hand picture was taken from the normal right thigh. The left-hand picture was taken with the sound beam sweeping from normal into tumor tissue. The deep signals *X* were believed to arise from the tumor. (The line *X–X* was almost continuous in the negative.) Had the machine been more powerful the tumor would probably have been outlined by an echo pattern within the area enclosed by the crosses, which were added to the record as shown.

and the rubber-membrane-air interfaces *X–X* were also traced out. The absence of signals beyond the rubber membrane when the sound beam swept out of the tissue into air (position *A*) was clearly recorded. Theoretically such a picture could be observed with the naked eye by moving the echogram *G* rapidly enough to obtain visual persistence on the face of the cathode-ray tube, but the apparatus was not sufficiently well developed at the time.

A limited clinical trial of two-dimensional echography was decided upon. A patient (Case No. 782,109) was hospitalized for a recurrence of a tumor on the inside of the left thigh above the knee. The tumor, which had been previously diagnosed as a myoblastoma by biopsy, could be palpated in the adductor muscles, but no swelling of the skin was observed over it. Two two-dimensional echograms obtained from this

patient are shown collectively in Fig. 8. The echogram of the normal right thigh is shown to the right. The two-dimensional echoscope (Fig. 5) was positioned in a comparable site on the left thigh in such a way that the sound beam swept from normal into tumor tissue. The two-dimensional echogram shown to the left in Fig. 8 was obtained. The signals *X–X* were believed to arise from the growth as the sound beam swept into it. These signals were almost continuous in the negative. Had the apparatus reached a greater state of perfection, the tumor might have been revealed by echo patterns within the area enclosed by the cross-lines inserted on the record.

Further development of the methods described for examination of living, intact, biological tissue in such a manner as to reveal structure in depth should be of great value in many branches of biology. The immediate application of echography to the detection of tumors in accessible sites in the living intact human organism is envisaged.

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News and Notes

The Wenner-Gren Summer Seminar in Physical Anthropology

For the past six summers a changing group of physical anthropologists and allied specialists has met by invitation at the Wenner-Gren Foundation for Anthropological Research (formerly the Viking Fund) through the foundation's generous support. These seminars have been organized and led by S. L. Washburn, of the University of Chicago.

The purpose of the sessions has been to examine the theoretical bases of the whole subject, the validity of its methods, the transfer of techniques and results from other fields, and the application of all these to specific data. The goal is to outline both key problems of the field and the most fruitful approaches to their solution. The first few sessions were designed to clarify aims and terminology and to analyze some of the assumptions, techniques, and methods of investigation and interpretation, using concrete examples. Foreign as well as American specialists have attended to demonstrate new fossil material and new methods.

The concurrent *Yearbook of Physical Anthropology*, edited by Gabriel W. Lasker, describes each session. The work of the first four seminars was theoretical in aim: evaluation of process and critical scrutiny of various classificatory, experimental, and genetic concepts, and of assumptions both long-accepted and novel; the first three concentrated on human evolution, race, constitution, and growth. The fourth seminar, more specific, was divided into two main topics: the Australopithecinae of South Africa, and methods used in study of the American Indian. The fifth differed in being exclusively concerned with techniques and materials, which were considered under three main heads: (1) new ways of dating fossil and archaeological material, including C^{14}, fluorine salt concentration, and spectrographic analysis; (2) improvements on, and additions to, existing techniques in anthropometry; (3) statistical handling of data and problem planning.

The sixth seminar was a synthesis of the work of the first five. Its aim was to reach agreement on what would make a reasonably balanced program for graduate students in physical anthropology, covering the field in terms of its subdivisions. The 1951 meetings did much to shape the philosophy of a more unified physical anthropology. Among tangible results are a series of brief statements representing prevailing points of view, an outline of areas needing further research to reach agreement, and minimal reading lists, which were amended through suggestions sent in by nonattending members of the American Association of Physical Anthropologists. These are published in the *Yearbook of Physical Anthropology, 1950*.

A summary of major topics at this seminar follows:

1) *Human genetics* is basic in understanding human evolution (process of interaction between mutation, changing population size, genic loss, mixture, selection, and isolation) and race differentiation as an evolutionary product. Analyses of the same populations by phenotypic and genetic methods should give the same results, but until genes and growth processes involved in functional trait constellations are better understood, further race classification means little, although blood group analyses already give a partial check. Since genetic analysis has to use specific anatomical characters, and since the phenotypic concept of race is a constellation of overlapping trait groups held together in unstable combinations in breeding isolates of widely varying size, the two approaches are less antithetical than they seem, and phenotypic similarity may continue to suggest biological relationship. It is now essential to learn more of breeding patterns and to multiply our knowledge of specific human characters.

2) *Primate studies*, comparative and experimental, bear on the development, ecology, and physiological functioning of man and can apply to medical and growth problems involving relation of form to function.

3) *Fossil primates and fossil man* have prompted new studies in which emphasis has shifted from comparative description to the evolutionary processes involved. A grasp of the history of evolutionary theory is also neces-

sary to assess past work in the light of modern findings.

4) *Measurement* must remain a descriptive technique and not a categorizing one. For specific problems new measurements must be devised, and, except where simple description is an end in itself, a complex of changed measurements resulting from a single variation or adjustment to environment must be identified correctly as a unit.

5) *Growth* now includes prenatal development and senile degeneration. Particular attention must be given to differential rates of change in parts and complexes. The number of variables affecting growth must be reduced by such methods as matched pair and twin studies, plus such statistical treatment as factor analyses and discriminant functions.

6) *Constitution* concerns variation among individuals, with wider implications than in the Sheldonian system, the assumptions of which have not been validated and need modification to avoid oversimplified fallacy. In special need of research with more precise techniques are the tenuous relationships between body build and psychotype, on the one hand, and physiological, genetic, and social patterns on the other.

7) *Human ecology*, in stressing the relationship of the human organism to its total environment, becomes a point of view that links biological and social aspects of anthropology.

8) *Applied physical anthropology* need not constitute a separate subfield, since all studies should have varying degrees of applicability and of theoretical significance.

9) *Race* is not a subfield apart from the evolutionary processes that unite all the subfields discussed, because race differences are simply different balances among selective forces, mutations and genic loss, and ecological history of breeding groups.

Physical anthropology emerges as neither static nor purely descriptive, but as increasingly concerned with total human biological dynamics.

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Scientists in the News

W. A. Aitken, of Merrill, Iowa, has joined the staff of the American Veterinary Medical Association as editor-in-chief of publications. Included in the publications coming under his supervision is the *Journal of the American Veterinary Medical Association*. Dr. Aitken was engaged in the general practice of veterinary medicine in Merrill for 21 years prior to accepting this appointment.

William H. Bessey, formerly with the Carnegie Institute of Technology, has been appointed associate professor of physics at the Missouri School of Mines and Metallurgy.

R. S. Breed, professor emeritus of bacteriology (Cornell University), Geneva, N. Y., has tendered his resignation as permanent secretary for nonmedical bacteriology to the International Committee on Bacteriological Nomenclature. Professor Breed was designated as a permanent secretary of this committee at the First International Congress of Microbiologists held in Paris in 1930, and has filled the position for 21 years. He asked to be relieved of his duties so that he may devote his full time to the preparation of the seventh edition of the *Bergey Manual of Determinative Bacteriology*, of whose editorial board he is the chairman. **Torsten Wikén,** director of the Institut für landw. Bakteriologie und Gärungsbiologie at the Swiss Federal Institute of Technology in Zurich, has been chosen to succeed him. Dr. Wikén, who studied at the University of Uppsala, and was later assistant in the limnological laboratory of the University of Lund and at the Institute of Medical and Physiological Chemistry at Uppsala, is associate professor of plant physiology and anatomy.

The Buffalo Surgical Society has presented the Roswell Park Memorial Medal, for "outstanding surgical achievement," to **Edward D. Churchill,** of Boston. Dr. Churchill, fifth recipient of the award, delivered the annual Roswell Park Lecture, entitled "The Architectural Basis of Pulmonary Ventilation," at the presentation ceremonies.

James De Juren has joined the Atomic and Radiation Physics Division of the National Bureau of Standards, to assist in the program of calibrating neutron standards and neutron detectors against the National Neutron Standard. Dr. De Juren has been at the University of California Radiation Laboratory.

Augusto Durante, mining and civil engineer from Brazil, is in this country, representing the Institute of Geology and Geography under the Brazilian Secretary of Agriculture. He is on leave of absence from the institute and, with the cooperation of the U. S. Geological Survey, he will visit field offices of the Survey in Louisville, Baton Rouge, Houston, Austin, Silver City (N. Mex.), and Denver, as well as the Washington, D. C., headquarters.

The following were recent visitors at the Eastern Regional Research Laboratory of the Agricultural Research Administration at Philadelphia: **Antonio B. O. Estevez,** Merck & Company, Rio de Janeiro; **K. H. Shindler,** European Industrial Products, Toronto; and **Francisco D. Santana,** Philippine Islands.

Matti Olavi Franssila, chief of the weather forecasting section of the Finnish Department of Meteorology and lecturer at the University of Helsinki, will serve as project coordinator at the University of Wisconsin during the coming year. Dr. Franssila came to the U. S. at the invitation of Verner Suomi, chairman of the Department of Meteorology, and will work closely with Dr. Suomi and Reid Bryson. He is a specialist on microclimatology.

Curtis M. Hilliard, professor of biology and public health at Simmons College since 1914, will retire on June 30. **Philip M. Richardson,** of Wellesley, professor of biology, who has been on the Simmons

faculty since 1930, will succeed him. Dr. Hilliard will continue to serve as supervisor of health for Wellesley, Weston, and Needham.

F. Houtermans, of the Max Planck Institute, Göttingen, has accepted a professorship in the Physics Department of the University of Bern. Dr. Houtermans is a nuclear physicist whose recent research has been concerned with age determinations by radioactive methods.

Thomas J. Killian has been appointed chief scientist of the Office of Ordnance Research at Duke University. Before his appointment to the ordnance post, he was science director and deputy assistant chief for research, ONR, Washington. Dr. Killian will head a group of scientists in directing and coordinating the Army Ordnance Corps' basic research program.

Vernon B. Link has been designated deputy officer in charge of the Communicable Disease Center, USPHS, Atlanta, succeeding **Justin M. Andrews,** who was deputy officer in charge for six years. Dr. Link was transferred to Atlanta from San Francisco, where for more than a year he has headed the center's plague investigations section. **Chris A. Hansen** has been designated executive officer, succeeding **Wesley E. Gilbertson,** who has been transferred to Washington; and **Jean S. Grant** has been designated assistant to the officer in charge.

Millicent C. McIntosh and **John Olin** have been elected to the Board of Trustees of the American Museum of Natural History. Mrs. McIntosh, dean of Barnard College, is the first woman elected to the Board of Trustees since the museum was founded in 1869. Mr. Olin is president of Olin Industries, Inc., of East Alton, Ill.

H. D. McKay, formerly an executive of the Vick Chemical Company, has become an independent management consultant. His retirement Feb. 1 terminated 36 years with Vick, 22 years of which he served as a director.

Amos C. Michael has been appointed associate professor of pathology in the school of medicine of the University of South Dakota. He was associated with the Department of Pathology at Indiana University prior to his present appointment.

Jacob Millman, formerly associate professor of electrical engineering at the College of the City of New York, has been appointed professor of electrical engineering at Columbia University.

J. H. Moses has been appointed chief geologist of the Reynolds Mining Corporation. Dr. Moses succeeds **Carl Schmedeman,** who died suddenly in December while on a business trip to Mexico.

G. P. S. Occhialini, of the Free University of Brussels and the University of Genoa, has been invited to go to Rio de Janeiro to participate in cosmic-ray research at the Nuclear Physics Institute. He is planning to spend about four months there before returning to Europe.

Don K. Price, associate director of the Public Administration Clearing House, has been named deputy chairman of the Department of Defense Research and Development Board. He succeeds **James A. Perkins,** who is returning to his position as vice president of the Carnegie Corporation of New York. Dr. Perkins will continue to serve the board in a consultant capacity. Mr. Price is a member of the Board of Directors and of the Executive Committee of the Social Science Research Council.

Robert William Quinn, associate professor of preventive medicine, University of Wisconsin Medical School, has been appointed professor and head of the Department of Preventive Medicine and Public Health at Vanderbilt Medical School. **Alvin E. Keller,** who has been acting head of the department, will continue as associate professor of preventive medicine and public health.

Robert Redfield gave a series of Messenger Lectures at Cornell on "The Primitive World and its Transformations." Dr. Redfield is professor of anthropology at the University of Chicago, and this year is to be an exchange professor at the University of Paris.

Irving G. Rosenberg has been appointed director of operations of Allen B. Du Mont Laboratories, Inc. He will be in charge of the television receiver and cathode-ray division. He joined Du Mont in 1942 and in his latest post was manager of the cathode-ray division.

J. Allen Scott, professor of statistics and epidemiology and director of the recently organized Laboratory of Helminth Research at the University of Texas Medical Branch, Galveston, has been appointed a member of the WHO Expert Advisory Panel on Parasitic Diseases.

A. J. Sharp, long a member of the Department of Botany at the University of Tennessee, has been appointed head of the department, and **Gordon E. Hunt,** of Cornell, has joined the staff as plant physiologist.

Joseph Trapold, formerly with the Department of Pharmacology, University of Tennessee, and **Alfred Renzi,** formerly with the Department of Biology, Syracuse University, are now associated with Ciba Pharmaceutical Products, in the Division of Macrobiology.

J. J. Wanderstock, assistant professor of animal husbandry at the Cornell University Agricultural Experiment Station, has joined the staff of the School of Hotel Administration, Statler Hall, Cornell University, where his primary responsibility will be with work in meats, poultry, and fish.

Dare A. Wells, University of Cincinnati professor of physics, has been granted a leave of absence to accept the invitation of the University of Córdoba,

Argentina, to serve as visiting professor of physics there for six months. Dr. Wells will give a graduate course in Lagrangian dynamics and a course in atomic physics. He has also been asked to assist the university in reorganizing its graduate program in physics.

Oram C. Woolpert has been appointed executive director of the Ohio State University Research Foundation. A former Ohio State faculty member, he has resigned as director of the Army's research center in biological warfare, Camp Detrick, Md., to assume the university post, in which he succeeds **James S. Owens,** who resigned Dec. 31. Dr. Woolpert will direct activities of the nonprofit institution which administers cooperative research projects under industrial and governmental sponsorship. During the past fiscal year, the foundation carried on 52 projects for industrial organizations and 99 for governmental agencies under contracts totaling more than $2,000,000.

Paul Zinner, regional director of Region V at Minneapolis, has been appointed chief of the Minerals Division of the U. S. Bureau of Mines in Washington, succeeding **Lowell B. Moon,** who has resigned to accept a position with the Kennecott Copper Corporation. **Paul T. Allsman,** who has been with the Denver office of the bureau, will fill the regional directorship at Minneapolis vacated by Mr. Zinner.

Education

The former corvette *Sackville* has been commissioned as an oceanographic vessel and assigned to the **Atlantic Oceanographic Group** at St. Andrews, N. B. She has been equipped with the latest navigational and scientific instruments and will aid in cooperative studies of the Atlantic and Pacific oceans under the sponsorship of the Canadian Joint Committee on Oceanography, which is composed of representatives of the Fisheries Research Board, the Hydrographic Service, the National Research Council, and the Royal Canadian Navy.

Effective for the 1952–53 academic year, daughters of electrical workers will be eligible for four-year scholarships at **Barnard College,** followed by two years at an approved school of medicine or dentistry. This is an extension of the joint labor-management project launched by the Joint Industry Board of the electrical industry in 1949 for the sons of electrical workers who wish to study engineering at Columbia. Such scholarship holders may now substitute the study of medicine or dentistry upon graduation.

Duke University will offer for the second summer a course in acarology, from Aug. 18 to Sept. 5. It is designed for advanced students, and particularly for professional entomologists, parasitologists, and zoologists who wish to know more about the Acarina. Special emphasis is placed on species of medical or economic importance. Further information may be obtained from G. W. Wharton, Department of Zoology.

At the **University of Maryland the Institute for Fluid Dynamics and Applied Mathematics** public lectures began on Feb. 19 with **Adolf Busemann** as the speaker. Sydney Chapman, of Queen's College, Oxford, will speak Mar. 11, 12, and 13; Marshall H. Stone, University of Chicago, April 29 and 30, and May 1; George E. Uhlenbeck, University of Michigan, May 5, 6, and 7; and Mark Kac, of Cornell, May 13, 14, and 15. The institute will also sponsor a meeting on Elasticity Mar. 21–22.

A field course in plant taxonomy and ecology will be offered by the Department of Botany at the **University of Michigan** June 23–Aug. 16. Instructors and students, traveling by bus, will investigate botanical variations, floristic composition of major areas, and dynamics of individual plant communities in Indiana, Illinois, Missouri, Oklahoma, and the Texas Big Bend country. Rogers McVaugh, Elzada U. Clover, and Pierre Dansereau (to whom inquiries should be addressed) will comprise the staff. Applications for the course should be mailed before *Apr. 1,* accompanied by a deposit of $40.00 for Michigan residents and $100 for nonresidents.

North American Philips Company, Inc., will hold its twelfth semiannual X-ray Diffraction School at its plant, 750 S. Fulton Ave., Mt. Vernon, N. Y., Apr. 21–Apr. 25. Basic subjects covered will be new high- and low-temperature camera techniques, fluorescence analysis, Geiger counter, X-ray spectrometer, and electron microscopy and diffraction. Those interested in attending the school should register with the company at once.

The Nieuwland Lectureship, established at **Notre Dame** in 1946 in memory of the famous chemist and botanist, will be held this year by Selman Waksman, who will lecture on Mar. 31 and Apr. 1 and 2 on the general topic of "Actinomycetes and their Antibiotics."

Roosevelt College will present six lectures in a public institute on "New Frontiers of Science and Industry." Victor Conquest, of the Armour Research Division, spoke on Feb. 27, and Harold Urey, of the University of Chicago, will speak on Mar. 5. Other speakers will be Leonard F. Yntema, of Fansteel Metallurgical Corporation, Mar. 12; A. L. Elder, of Corn Products Refining Company, Mar. 19; George Hartmann, of Roosevelt, Mar. 26; and William W. Bauer, of the American Medical Association, Apr. 2.

Robert A. Moore, dean of the **Washington University School of Medicine** and president of the American Association of Pathologists and Bacteriologists, has left for Bangkok, where, as director of the Washington University–Thailand medical schools teaching assistance program, he will spend four weeks delivering lectures in pathology and observing results of the exchange program. Of the ten Washington U faculty members who went to Bangkok last summer (SCIENCE, **113,** 540 [1951]), eight are still in residence and will

remain until June, when they will be replaced by other faculty members. Twenty-two Thai students have enrolled at the St. Louis school.

Grants and Fellowships

Baxter Laboratories, Inc., Morton Grove, Ill., are offering ten fellowship grants for graduate research in the basic medical sciences and related disciplines. Students now holding other fellowships or scholarships are eligible. Application forms (returnable by *Apr. 1*) may be obtained from the Fellowship Committee of the laboratories.

Imperial Chemical Industries Limited, publishers of the scientific review *Endeavour,* are offering, as a contribution to the meeting of the British Association for the Advancement of Science to be held in Belfast Sept. 3–10, a sum of 100 guineas to be awarded as prizes for essays on scientific subjects. The competition is restricted to scientists under 25. Five prizes will be awarded, and successful competitors will be invited to attend the Belfast meeting, at which the prizes will be presented. Their expenses within the U. K. will be paid. Closing date for receipt of entries is *June 2.* For full information, write to the Assistant Secretary, BAAS, Burlington House, Piccadilly, London, W. 1.

Jefferson Medical College and Hospital, of Philadelphia, will have a fellowship in obstetric and gynecologic endocrinology available *July 1.* At least one year of preliminary training in the field is required. Requests for application blanks should be sent at once to Lewis C. Scheffey, chairman, Department of Obstetrics and Gynecology.

The Bell Telephone Laboratories **Frank B. Jewett Postdoctoral Fellowships** for 1952–53 have been awarded to Murray Gerstenhaber (mathematician), of Harvard and New York City; Ernest M. Henley (physicist), of the University of California and Forest Hills, N. Y.; Emin T. Onat (mathematician), of Brown University and Yenisehir-Ankara, Turkey; Henry Helson (mathematician), of Yale and New Haven; and Paul N. Schatz (chemist), of Brown University and Philadelphia. Dr. Gerstenhaber was also among the winners last year.

March of Dimes funds amounting to more than one and three quarter million dollars will aid research and teaching institutions throughout the U. S. and Canada in their studies of poliomyelitis and in the training of professionals to carry on research and provide adequate patient care. Largest amounts went to the University of Pittsburgh, where Jonas E. Salk, research professor of bacteriology, will carry on research; and to the University of Michigan, for work under the direction of Thomas Francis, Jr., professor of epidemiology.

A New York Puerto Rican Scholarship Fund has been established to provide funds for graduate and undergraduate work for both men and women of exceptional ability. Raymond M. Hilliard, director of the Welfare Council, and Henry L. McCarthy, Commissioner of the New York City Department of Welfare, were incorporators of the fund; other fund members belong to the Mayor's Committee on Puerto Rican Affairs in New York. An exhibit by Puerto Rican artists and a musical program will be held Apr. 15 at Hunter College to assist the fund.

Sandoz Pharmaceuticals Company, of New York, has made a grant to H. R. Henze, of the Department of Chemistry, University of Texas, and G. A. Emerson, of the Medical Branch of the University of Texas, Galveston, who will collaborate in the investigation of drugs to treat epilepsy and other convulsive ailments.

Sharp & Dohme has made a grant in support of the work of Edwin L. Rushia, University of Arkansas, in the anesthesiology of two of its products, Aramine, a vasoconstrictor, and Cyclaine, a local anesthetic. The pharmaceutical firm will also support clinical investigation of a new antibiotic agent for the treatment of bovine mastitis. The work is being done by A. R. Drury, of Michigan State College, for the Michigan State Board of Agriculture.

The **Society of Women Engineers,** organized in 1949, will initiate its first award in 1952. An SWE Award will be conferred upon a woman who has made a significant contribution to engineering practice, research, education, or administration. Nominations will be accepted from society members or from nonmembers familiar with the field.

Four **Westinghouse War Memorial Scholarships** are open to sons of Westinghouse employees who have not less than five years of service (Class A) and to employees of the company with at least two years of continuous service prior to May 1, 1952 (Class B). Class A applicants must be in their senior year in high school or must have graduated since Nov. 1, 1951; Class B applicants may not be over 23, except in the case of veterans. Filing of an application for the fellowships also automatically registers the applicant for consideration for the George Westinghouse Scholarships.

In the Laboratories

Beckman Instruments, Inc., has purchased 40 acres in the Fullerton-La Habra (Calif.) area for the construction of a new research and manufacturing center. Long-range plans include centralization of the various Beckman divisions—the Helipot Corporation, manufacturer of precision potentiometers, and Arnold O. Beckman, Inc., manufacturers of an oxygen analyzer and various radiation detectors. The Beckman operations are at present distributed over 14 different locations in the Pasadena area.

Central Scientific Company will soon occupy its new Los Angeles plant on Telegraph Road, which will be linked by teletype to Cenco branches in San Francisco and Santa Clara, as well as to the main offices and factory in Chicago.

Ethyl Corporation research laboratories have appointed Edward J. Johnson staff assistant to Harold Soroos, superintendent of Chemical Services. Theodore J. Carron succeeds him as head of the Chemical Engineering Section.

Lester C. Higbee, formerly secretary and director of engineering for **W. & L. E. Gurley,** manufacturers of engineering and scientific instruments, has been elected president of the firm. Charles E. Smart, retiring president, will serve as chairman. Robert G. Betts was elected to the new office of executive vice president, Daniel Harkness was named secretary, and William A. Rockefeller assistant treasurer.

New laboratories for the **Koppers Co., Inc.,** are nearing completion in Verona, Pa. The company is building a pilot plant to make gasoline from coal by hydrogenation, a process using powdered coal in a slurry, reactions taking place under high pressure. Particular emphasis will be put on the production of various chemicals.

Meetings and Elections

A Northern New York Section, with headquarters in Potsdam, becomes the 139th local section of the **American Chemical Society,** which now has 67,000 members in all states, the District of Columbia, Puerto Rico, and Hawaii. Francis W. Brown was elected chairman. Other officers are: vice chairman, Donald G. Powell, and secretary-treasurer, William K. Viertel.

The Division of High-Polymer Physics of the **American Physical Society** will meet in Columbus, Ohio, Mar. 20–22. Two symposia and three sessions for contributed papers have been arranged. Maurice L. Huggins has been elected division chairman, and Raymond F. Boyer vice chairman. W. J. Lyons was re-elected secretary-treasurer.

The fifth annual **Industrial Microbiology Institute** will be held at Purdue University July 21–26. The institute is designed particularly for industrial and university scientists who are working with molds and fungi and their identification and control. In addition to the Purdue staff, Joseph C. Gilman, president-elect of the American Mycological Society, David Gottlieb, and H. B. Woodruff will speak. Inquiries will be answered by the Division of Adult Education.

The **International Council of Women Psychologists** has elected Lillian Portenier president for 1952–53 and Dorothy Van Alstyne and Margaret Ives vice president and secretary-treasurer, respectively. Tomika Wada Kora, of Tokyo, and Katharine Banham, Clara C. Cooper, and Helen Shacter were elected to the Board of Directors.

A seminar on the results of the **International Wool Research Project** will be held Apr. 7–9 at Lowell Textile Institute under the auspices of the Wool Bureau, Inc. Industry representatives or others interested in wool science and technology are invited to attend, and may obtain further information from Giles E. Hopkins, 16 W. 46th St., New York 19.

A **National Colloid Symposium,** the 26th, sponsored by the ACS Division of Colloid Chemistry, will be held at the University of Southern California June 16–18. Most of the program will be made up of invited papers, but contributed papers will be considered by the Symposium Committee, of which W. O. Milligan, Rice Institute, Box 1892, Houston 1, Texas, is chairman. Prospective authors should send to the chairman, prior to *Apr. 1,* a tentative title and, prior to *Apr. 15,* three copies of a 200-word abstract.

The Wallace Clark Award of the **National Management Council,** for distinguished contributions to scientific management in the international field, was given to René de Valliere, of Zurich, at its annual meeting in January. The Swiss consul general, Frederick Cygas, accepted the award for Professor de Valliere. A. M. Lederer was elected president of the council, succeeding Edridge Haynes; Harold F. Smiddy, Marcell N. Rand, and Erwin H. Schell were elected vice presidents; and Fred Rudge and Allen Ottman were re-elected secretary and treasurer, respectively.

The **National Society for Medical Research,** meeting in Chicago in February, re-elected Anton J. Carlson president and Andrew C. Ivy secretary-treasurer. Seventeen organizations were added to the roster of member associations. William Bachrach, of the University of Southern California, Leo Brown, of the American Medical Association, John Paine, of Buffalo General Hospital, the Chicago *Tribune,* and the Chicago *Sun-Times* were voted awards for outstanding service to medical science.

At the close of the American Medical Association meetings in Los Angeles, Max Sadove was elected organizing president of the **Walter Reed Society** (SCIENCE, **114,** 476 [1951]). Clinton H. Thienes, Lloyd D. Seager, and John P. McGovern were elected vice presidents, and Betty Jenney was elected secretary-treasurer.

Sigma Gamma Epsilon, national honorary professional fraternity for college students of the earth sciences, elected Clark B. Carpenter president at its biennial meeting in Hot Springs, Ark., last December. Edward V. O'Rourke, J. Norman Payne, and Bronson Stringham were elected vice presidents, Willam R. Higgs secretary-treasurer, Paul D. Proctor editor, and Ralph E. Esarey historian.

The **Torrey Botanical Club** has elected the following officers: president, Marion A. Johnson; vice presidents, Murray Buell and Lindsay M. Black; secretaries, Jennie L. S. Simpson and Donald P. Rogers; treasurer, Elva Lawton; editor, Charles A. Berger. P. W. Zimmerman and R. H. Cheney will continue as AAAS Council representatives.

Technical Papers

Toxicity of Cellulose Acetate Sheets to Plants and Fish

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In a series of experiments on insect transmission of plant viruses carried out in 1949, cellulose acetate cages were used for confining the insects on plants. Transparent cellulose acetate sheets, 0.020 in. thick, obtained from a commercial house, were used. When crimson clover plants (*Trifolium incarnatum* L.) were placed under the cages they developed characteristic lesions on the leaflets within 3 days (Fig. 1, *a, b, c, d*), and most of them died within 2 weeks.

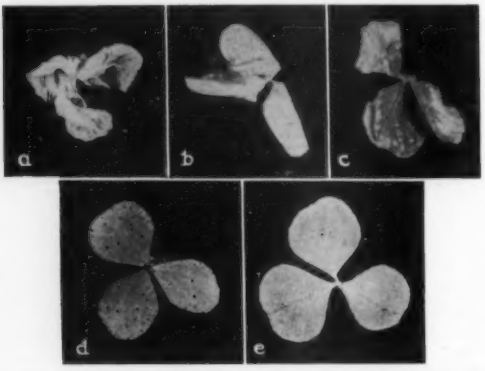

FIG. 1. *a, b, c, d*: Leaflets of crimson clover showing lesions and burning symptoms caused by toxic cellulose acetate sheets; *e*: normal leaflet. (Photographs by A. J. Carlile.)

Sheets of cellulose acetate from other sources were tested, and the material from one proved to be nontoxic. A spectrophotometric analysis[1] of different kinds of cellulose showed that the toxic sheets contained diethyl phthalate.

On inquiry it was learned that most manufacturers of cellulose acetate sheets used diethyl phthalate as the plasticizer. A comparison of the effects of toxic cellulose acetate cages and c. p. diethyl phthalate was therefore made. Crimson clover plants were caged under bell jars with small vials containing diethyl phthalate. Lesions similar to those produced by the toxic cages appeared on the leaflets. When a single leaflet was brought in contact with diethyl phthalate, the plant developed characteristic lesions and died within 3–5 days. The toxic effect was also tested on aster (*Callistephus chinensis* Nees) and tobacco (*Nicotiana tabacum* L.). Aster plants were found less susceptible, whereas tobacco proved to be more sensitive.

[1] The author is indebted to George I. Lavin and Herbert Jaffe for the spectrophotometric analyses.

Storage, or soaking the sheets in water, had little or no effect on the toxicity of cellulose acetate. Since toxic cellulose acetate tasted bitter it could easily be distinguished from the nontoxic material. Diethyl phthalate is bitter, has a boiling point of 295° C, and is nearly insoluble in water. It was found that soaking toxic cellulose acetate cages in alcohol, in which diethyl phthalate is miscible, removed most of the toxicity but caused so much shrinking of the material that it became unsuitable for use in the construction of insect cages.

The toxic effects of diethyl phthalate and of cellulose acetate sheets containing it are not limited to plants. Fish were exposed to the cellulose acetate material known to be toxic to plants, by confining them in water in a fishbowl in which small pieces of the material were immersed. They died within a few hours, despite the low solubility of diethyl phthalate in water. For a more precise test, sheets were cut into pieces, approximately 300 mg each, and 1–50 pieces were immersed in Erlenmeyer flasks containing 50 ml water. Three g of the material killed a 1½-in. goldfish within 45 min, 0.3 g within 4½ hr, and 1 drop of diethyl phthalate in 50 ml water within 30 min. Cellulose acetate powder and sheets of nontoxic cellulose acetate, as well as cellulose nitrate sheets, had no toxic effects on plants or fish. The results indicate that small amounts of diethyl phthalate are highly toxic to both fish and plants.

In a limited number of tests with mice, adding toxic cellulose acetate sheets to their drinking water produced no harmful effect.

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The Distribution of S^{35}-Labeled L-Methionine Sulfoximine in the Rat[1]

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It has been shown by various investigators (*1–3*) that methionine sulfoximine is the toxic agent produced by treating prolamines with nitrogen trichloride. The sulfoximine has been isolated from agenized flour and recently synthesized (*4, 5*).

When injected or fed to susceptible animals, convulsions may develop after a period of several hours, and the animals may die if the dose is high enough. There is evidence that methionine sulfoximine is a methionine antagonist, and Reiner (*6*) has shown that the convulsions produced by the drug in rabbits may be delayed or suppressed by feeding excess methionine.

[1] This project has been supported by the Office of Naval Research, Navy Department.

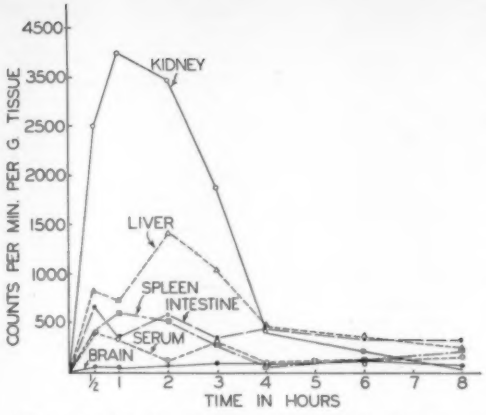

FIG. 1. Distribution of S^{35} L-methionine sulfoximine in rat tissues.

Inhibition of the growth of *Leuconostoc mesenteroides* (*7*) is also reversed by extra methionine. If the nervous symptoms are indeed caused directly or indirectly by a methionine antagonist, this would suggest that methionine has some as yet unknown function in nerve metabolism. If the distribution of methionine sulfoximine in the animals affected by the drug could be determined, this might give a clue to its mode of action. The work described below was undertaken in order to obtain information bearing on these questions.

In the synthesis of S^{35}-labeled L-methionine sulfoximine, several modifications of the original method (*4*) have been made; S^{35}-labeled DL-methionine (84 mg = 1.5 mc) was diluted with 10 g of inactive DL-methionine, the mixture benzoylated, and then resolved enzymatically by the method of Dekker and Fruton (*8*). The first crop of crystals of S^{35} L-methionine weighed 1.04 g and had a specific activity of 21,000 cpm/mg as counted in a gas flow Geiger tube. The L-methionine (1.04 g) was converted to the sulfoxide by the method of Toennies and Kolb (*9*). The yield was 0.96 g. A chromatogram was run, using 0.05% butanol-acetic acid, and this gave R_f ascending 0.13. The R_f of pure methionine sulfoxide is 0.13. Two faint additional spots were nonradioactive. The S^{35} methionine sulfoxide (0.96 g, 0.007moles) was placed in a 15-ml three-necked flask equipped with dropping funnel, stirrer, and gas delivery tube, the end of the tube being placed several millimeters below the surface of water in a beaker. The flask was cooled in an ice bath, and 2 ml of concentrated H_2SO_4 was added with stirring. When most of the sulfoxide had dissolved, the temperature was raised to 45° C by means of a water bath, and 0.60 g (0.014 moles) of HN_3 dissolved in chloroform was added over a period of 1 hr, the temperature being maintained between 45°–50° C. (The HN_3 concentration should be 1.5 *N* or greater.) The progress of the reaction may be followed by the evolution of nitrogen. When all the HN_3 had been added, the stirring was continued for several hours, and the mixture allowed to stand overnight. A drop of the reaction mixture was adjusted to pH 5.5, and chromatograms were run as before and compared to pure methionine sulfoximine. No methionine sulfoxide remained. (If the chromatogram indicates the presence of sulfoxide, additional HN_3 may be added.) The reaction mixture was poured into a small amount of cracked ice and brought to pH 5.5 with $BaCO_3$. The $BaSO_4$ formed was filtered and washed with hot water until the washings gave a negative ninhydrin test. The combined filtrate and washings were then evaporated *in vacuo* to about 5 ml. Any precipitate is filtered, and the filtrate was further evaporated nearly to dryness. The residue was dissolved in the least possible quantity of hot water, and an equal volume of methyl alcohol added. On cooling in the refrigerator overnight crystals of methionine sulfoximine formed. They were recrystallized from a small quantity of hot water. The yield was 0.434 g of the sulfoximine having the same specific activity as the L-methionine.

Uptake of S^{35} L-methionine sulfoximine by rat tissues. Eight rats were injected intraperitoneally with 14–15 mg of the sulfoximine and then autopsied at intervals up to 8 hr. After 2–3 hr the rats not sacrificed developed convulsions, or incipient convulsions, and one died at 8 hr. Tissues investigated were liver, kidney, spleen, intestine, brain, spinal cord, and serum. Samples of each were digested with Pirie's reagent (*10*). The sulfate formed was precipitated as barium sulfate and then assayed according to the method of Boursnell *et al.* (*11*), using, however, a gas flow Geiger tube with standard geometry. The activities of the tissues are shown in Fig. 1. Activity was highest in the kidney, but this probably represents a very high excretion of the drug in the urine. Several urine samples were collected after 4–5 hr, and they showed activities up to 40% of the injected dose. At the end of 8 hr kidney activity had fallen almost to background, but liver and intestine still contained moderate activity, suggesting actual incorporation of the radioactive sulfoximine, or a derivative of it, in these tissues. The low uptake by brain and spinal cord

TABLE 1

UPTAKE OF S^{35} DL-METHIONINE BY LIVER SLICES WITH AND WITHOUT ADDED DL-METHIONINE SULFOXIMINE

With methionine sulfoximine			Without methionine sulfoximine		
Sample No.	Cpm/g liver slice	μg S^{35} DL-methionine taken up/g tissue	Sample No.	Cpm/g liver slice	μg S^{35} DL-methionine taken up/g tissue
1	14,570	51	6	32,200	133
2	10,380	36	7	33,700	139
3	9,340	33	8	31,100	129
4	18,170	63	9	33,900	140
5	15,410	54	10	22,760	94
Av	13,574 ± 1640	48 ± 6		30,732 ± 1050	127 ± 9

during the period of the experiment is of considerable interest.

To test the effect of DL-methionine sulfoximine on the uptake of S^{35}-labeled DL-methionine by liver slices, they were washed in cold Krebs' isotonic medium for 30 min, blotted dry, and weighed. Approximately 0.5-g samples were incubated in 15 ml Krebs' isotonic solution at pH 7.4 for 130 min at 37° C in an air atmosphere. The media contained (1) 30 mg S^{35} DL-methionine/100 ml, (2) 30 mg S^{35} DL-methionine, plus 30 mg of unlabeled DL-methionine sulfoximine/100 ml. Activity of the methionine was 264,000 cpm/mg as counted in a "Q" gas tube. The results are given in Table 1.

The low uptake of methionine sulfoximine by brain and spinal cord indicates the probable absence of a direct effect of the drug on these tissues. One possible explanation for its action suggested by the results in Table 1 could be through its inhibition of methionine uptake by nerve tissue and thus inhibition of the synthesis of enzymes important to nerve metabolism. Additional work is under way to test this and other possibilities.

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Growth-Regulator Specificity in Relation to Ovary Wall Development in the Fig

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Calimyrna figs produced parthenocarpically by growth-regulator application are seedless (*1–3*). In addition to the fact that embryo development does not take place, the endocarp, or inner ovary wall, of the fruitlets (achenes) does not sclerify and impart hardness to the so-called "seed" as in the case of pollinated syconia (*4*). Parthenocarpic Calimyrna fig syconia produced during the 1951 season with benzothiazol-2-oxyacetic acid,[1] however, have been found to contain achenes with the endocarp tissue as completely sclerified as in syconia resulting from cross-pollination. Thus, parthenocarpic figs produced with this compound have a texture identical to those produced by the usual commercial procedure of caprification (cross-pollination).

These results demonstrate the high degree of specificity of the growth-regulating substances and the diverse reactions they induce. During the past five years, several growth-regulators have been found to induce parthenocarpy in the Calimyrna fig, a variety that requires the stimuli of pollination and fertilization in order for the syconia to set and mature. Ovary wall development of achenes in syconia induced to develop parthenocarpically by three of these compounds has been investigated histologically. In each case some pronounced modification from the normal development and composition of the ovary wall has been revealed. In syconia produced with γ-(indole-3)-*n*-butyric acid, the endocarp in the individual achenes was completely absent (*4*). The endocarp of achenes in syconia produced with *p*-chlorophenoxyacetic acid, on the other hand, was observed to have developed, but typical sclerification of this tissue did not take place. Hence, the tissue did not become hard, but remained parenchymatous in character. Figs produced with this compound have become known commercially to the trade as "miracle seedless figs," because they do not contain achenes which characterize pollinated figs.

Benzothiazol-2-oxyacetic acid, when applied at a concentration of 100 ppm, induced 100% of the unpollinated but pollen-receptive syconia to set and mature parthenocarpically, with no injury to fruits or foliage. Of these, 80% matured at the same time as pollinated syconia, and 20% of the induced parthenocarpic figs reached maturity 3 weeks following the date of spray application, a response similar to that obtained with 2,4,5-trichlorophenoxyacetic acid (*5*). The syconia that matured approximately 6 weeks previous to the time of maturity of pollinated syconia contained achenes, the endocarp tissue of which did not sclerify. The process of endocarp sclerification did not take place, apparently because the time interval between growth-regulator application and maturity of the syconia was too short. Benzothiazol-2-oxyacetic acid-induced parthenocarpic syconia that matured at the same time as pollinated syconia, however, contained achenes with a completely sclerified endocarp. With the exception of slight differences in color of the pulp and lack of both endosperm and embryo development in the achenes, the parthenocarpic syconia appeared identical to pollinated syconia as regards shape, size, and texture.

It is significant that the most pronounced influence of the growth-regulating compounds inducing parthenocarpy in the Calimyrna variety of fig is morphologically manifest in a discrete tissue of the ovary wall. Hence, depending upon the growth-regulator used to induce parthenocarpy, distinctly different achenes can be produced. The following three distinct modifications from normally pollinated syconia, for example, are now possible in the Calimyrna fig: (*a*) syconia containing achenes in which the endocarp is lacking, [produced with γ-(indole-3)-*n*-butyric acid]; (*b*) syconia containing achenes in which the

[1] Supplied by the American Cyanamid Company.

endocarp is present but not sclerified (produced with *p*-chlorophenoxyacetic acid); and (*c*) syconia containing achenes in which the endocarp is present and completely sclerified (produced with benzothiazol-2-oxyacetic acid). Achenes in each of these types do not contain an embryo.

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Protective Effect of Glycine on Sperm Exposed to Light

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Spermatozoa of the purple sea urchin, *Strongylocentrotus purpuratus*,[2] were found to be about a million times as sensitive as eggs to ultraviolet light (*1*) at wavelengths absorbed by nucleoproteins. Spermatozoa of a number of other sea urchins, *S. franciscanus*, *Arbacia punctulata*, the sand dollar *Dendraster eccentricus*, and the starfish *Pateria miniata* were also found to be highly sensitive to these radiations (*2*). The injurious effect of ultraviolet light on *S. purpuratus* is partially reversed by small dosages of monochromatic visible light, especially at 4350 A (*3*). However, visible light also has an injurious effect on spermatozoa, immotilizing them and rendering them incapable of fertilizing the eggs. Dosages that do not immotilize the spermatozoa cause a slight delay in cleavage (*3*). The recent discovery by Tyler (*4–6*) that glycine protects spermatozoa against deterioration after dilution of the spawn suggested the possibility of protecting the spermatozoa against radiations by this means.

Accordingly, in all the following experiments on this species, the spawn issuing from a testis of *S. purpuratus* was diluted 1:400 in sea water solution containing 0.05*M* glycine (this being the concentration found optimal by Tyler), a similar suspension in sea water alone serving as control. A drop (about 0.01 ml) was withdrawn from each vessel at various periods and tested by adding to a dish containing about 300 eggs in 0.3 ml sea water, which was stirred by gently blowing with a pipette. Although there is variation in the longevity of sperm from different animals, untreated but diluted spermatozoa kept at 13° C in the dark lose their viability in 1–3 hr. In diffuse daylight (100–200 ft-c) and at a higher temperature (21° C), they remain virile less than an hour. In the presence of glycine, however, they remained virile for more than 20 hr (the longest time tested) in the dark at 13° C. Spermatozoa of the purple sea urchin are therefore protected by glycine in the same manner as those of the other species tested by Tyler and coworkers.

Glycine, however, offers no protection against injury by short ultraviolet radiations. Spermatozoa without as well as with glycine, irradiated with 50 ergs/mm² of λ 2654A from a quartz monochromator, were used to fertilize normal eggs. The resulting zygotes in both cases showed an 80-min delay in the first cleavage over unirradiated controls (for methods see [*3*]). Nor did the presence of glycine enhance photoreactivation by visible light of spermatozoa injured by ultraviolet radiations, the cleavage delay being the same in experimental and control.

On the other hand, glycine had a strong protective effect on spermatozoa treated with visible light. In most of these experiments the source of radiations was a GE CH-4 spotlamp (at 30 cm), and the light was filtered throug 8 in. of water and a #3060 Corning glass filter, which cuts off most of the long ultraviolet (λ 3660A and possibly somewhat shorter) but transmits most of the visible (30% at 4000A). The intensity, measured by a GE exposure meter, was about 3900 ft-c. Spermatozoa in sea water exposed to this light lost their viability in 5–10 min. In glycine solution they fail to fertilize eggs only after exposures of about an hour or more. Addition of glycine to spermatozoa that have been immotilized with white light does not revive them, whether the suspension had been treated in sea water or in glycine sea water. Treated with sunlight (1800 ft-c) through water cells to remove heat and the Corning #3060 filter to remove the ultraviolet radiations, the spermatozoa were killed in 10 min in sea water, but those in glycine sea water were still fully viable after 33 min.

Of the wavelengths tested, the visible light that is most effective in immotilizing spermatozoa of the purple sea urchin is the blue, λ 4350A; a dosage of 20,000–40,000 ergs/mm² affects almost 100% of the spermatozoa, as judged both by immotilization and by the failure to induce fertilization membranes or cleavage (the latter check being necessary since occasionally one finds membranes so close to the egg that fertilization might be questioned, yet cleavage occurs). Violet light, λ 4050A, is less effective than blue, immotilizing only after dosages of 60,000–70,000 ergs/mm². Wavelength 3660A in the ultraviolet was not effective even at dosages of 80,000 ergs/mm², the highest tried. Monochromatic yellow (5780A) was also ineffective even at a dosage of 80,000 ergs/mm². The compound responsible for the injury therefore seems to be something which absorbs strongly in the blue-violet portion of the visible.

The eggs of the purple sea urchin, although quite resistant to visible light filtered through the Corning #3060 filter, are also sensitive to the total radiations

[1] Present address: Department of Zoology, University of Missouri, Columbia.

[2] Collected at Moss Beach, Calif., for the work at Stanford and off the rocks near the laboratory for the work at the Hopkins Marine Station.

of the CH-4 arc (intensity: 5000 ft-c) filtered only through the water cells to remove heat. After an exposure of 45 min fertilization by normal sperm was not observed. Eggs similarly exposed but in 0.05 glycine remained fertilizable, as indicated by fertilization membrane formation or cleavage for at least double this time. Some became sticky in the glycine solution and adhered to the slide.

To extend the observations to spawn of a related form, the sand dollar *D. eccentricus*,[3] and of the echiuroid worm *Urechis caupo*,[4] were tested in a similar manner. The spawn of the sand dollar, diluted 1:200, resisted prolonged exposure (over an hour) to visible light from the CH-4 lamp filtered through the water cells and the #3060 Corning filter; therefore it was tested without the latter filter. In the absence of glycine a deterioration of spermatozoa occurred only after 30 min and was not marked until 40 min, after which exposure very few normal eggs were fertilized by addition of such spermatozoa. In the presence of glycine, however, comparable injury did not occur until after about 60 min exposure. There was little evidence of any protective action when a 1:2000 suspension of sand dollar sperm was tried, suggesting also a mass effect, which was not further investigated. The eggs were also relatively insensitive to the radiations from this lamp and fertilized normally even after more than an hour of exposure. Only after 2 hr exposure was a slight delay in cleavage observed. Clearly, the sand dollar spermatozoa and eggs are much less sensitive to visible light (and long ultraviolet light of this light source) than those of the sea urchin, although the two animals are not too distantly related.

Spermatozoa of *U. caupo*, in a 1:400 suspension proved to be highly resistant to visible light (3900 ft-c) of the CH-4 lamp passed through the Corning #3060 filter, as they are to ultraviolet light (*7*). After 40 min exposure, 95% (equivalent to the control) of the unexposed eggs added to the exposed sperm suspension were fertilized. After 60 min exposure a decline in fertilizing power of the spermatozoa occurred, only about two thirds of the eggs added being fertilized. After 80 min exposure still fewer were fertilized, and after an exposure of 145 min only about a third were fertilized. In all cases, observations were made for cleavage and formation of free-swimming larvae, to make sure that those eggs which failed to show membranes did not later cleave. *Urechis* spermatozoa in glycine sea water showed no significantly greater resistance to visible light than those in plain sea water.

The spermatozoa of *Urechis* were next treated to the full radiations of the CH-4 arc passed only through the water filters to remove heat. They proved much less resistant to the total radiations, which include some long wavelength ultraviolet light, than to visible light alone. After 10 min all eggs added to exposed sperm were fertilized, but after 15 min exposure only about half of the eggs added to the exposed sperm were fertilized, and after 20–30 min none were fertilized or cleaved. Where fertilization occurred, trochophores appeared in a day (18° C).

Eggs of *Urechis* were also treated to the full radiations of the CH-4 arc (minus heat), and they proved quite resistant. After 60 min exposure to this lamp, they still cleaved normally when fertilized with normal sperm and gave rise to normal trochophores.

The experiments indicate that the spermatozoa of the purple sea urchin are much more sensitive to visible light injury than those of the sand dollar or the worm *Urechis*. The relatively greater effectiveness of the blue region of the spectrum in injuring sperm of the purple sea urchin suggests the presence in the sperm of some photosensitizer that has a maximal absorption in the blue. The mechanism of the sensitization of these spermatozoa to visible light should be susceptible to experimental analysis.

[3] Dredged in Monterey Bay between the Hopkins Marine Station and Fort Ord, Calif.

[4] Collected at Elkhorn Slough near Moss Landing, Calif.

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Enzymatic Synthesis of Higher Carbohydrates from Dextrose

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By means of alcoholic fermentation, Pigman (*1*) observed the production of unfermentable carbohydrates by action of mold enzymes on maltose and reported no such synthesis from dextrose. Pan and associates (*2*) reported on the synthesizing action of *Aspergillus niger* enzymes on maltose, but the enzyme system failed to synthesize from dextrose. Tsuchiya *et al.* (*3*) have demonstrated by chromatographic techniques that *A. niger* enzymes synthesize oligosaccharides from maltose, isomaltose, and cellobiose, but direct synthesis from dextrose was not demonstrated.

TABLE 1

Progress in Synthesis of Dextrose

Hours of incubation	Relative reducing value of mixture (%)
0	100
69½	93.4
142	89.4
167	88.5
191	88.3
214	87.7
238	87.4

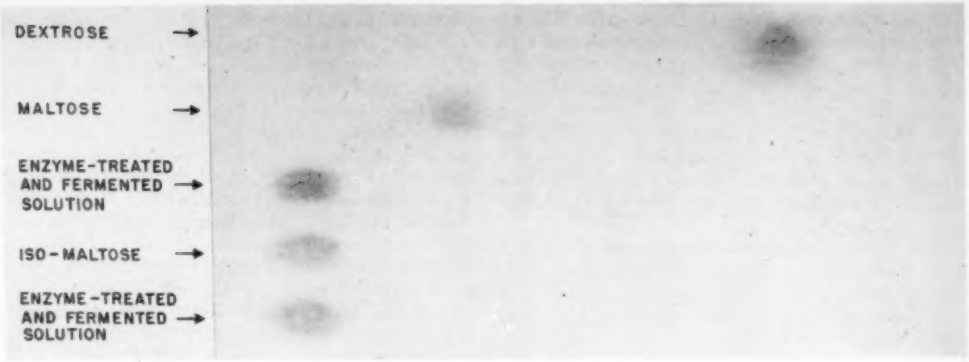

FIG. 1

We have observed the enzymatic synthesis of higher carbohydrates directly from dextrose, on which we wish to make a preliminary report.

A 47.5% dextrose solution, buffered to pH 4.6 with an acetate buffer (acetic acid–sodium acetate), and containing 4.07% of a purified precipitated enzyme preparation derived from *A. oryzae*, was kept under aseptic conditions for 238 hr at 53°–54° C. The enzyme preparation, which was assayed for α-amylase by the Sandstedt, Kneen, and Blish (*4*) procedure, contained 400 α-amylase u/g. Its Lintner value was 180 at 20° C. In addition, the enzyme preparation contained a relatively large amount of limit dextrinase.

The reducing value of the incubated mixture was determined by Lane-Eynon (*5*) titration at intervals in order to follow the progress of enzymatic synthesis. These values in terms of initial reducing value (100%) are shown in Table 1.

After 238 hr the fermentable carbohydrates were removed by fermentation with yeast; 66.6% of the dextrose originally present was fermentable. The fermented solution was decolorized with Darco, filtered with Celite, and evaporated to a syrupy consistency. No crystals have been obtained as yet.

The syrupy material was then chromatographed by the procedure of Jeanes, Wise, and Dimmler (*6*), using two descents to obtain the chromatogram shown in Fig. 1. In this chromatogram the mobility of duplicate spots of the sample was compared with dextrose, maltose, and isomaltose control spots. The chromatogram clearly shows that the unfermentable carbohydrates synthesized directly from dextrose by *A. oryzae* consist mainly of isomaltose. In addition, there is a smaller quantity of an oligosaccharide containing more than 2 dextrose units per molecule, since its mobility is less than that of isomaltose.

Preliminary experiments with an enzyme preparation derived from *A. niger* (NRRL 330)[1] also showed a synthesizing action on dextrose under identical conditions. The investigations will be continued.

[1] We are indebted to H. M. Tsuchiya, of the Northern Regional Research Laboratory, Peoria, Ill., for generously providing us with the *A. niger* (NRRL 330) culture filtrate.

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Analcime in the Popo Agie Member of the Chugwater Formation[1]

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Analcime (analcite, $NaSi_2AlO_6 \cdot H_2O$) has been reported as a sedimentary mineral in only a few occurrences, and in no large quantity except in the Green River (*1*) formation. Special interest attaches, therefore, to the recognition of analcime as the prominent mineral in a section of sedimentary rock ranging in thickness up to about 60 ft, and extending over thousands of square miles. This analcime rock is the ocherous Popo Agie member (*2*) (originally called the Popo Agie Beds [*3*]) of the Triassic Chugwater formation of western Wyoming.

In previous field work which has been done on the Popo Agie its uncommon and distinctive lithology has been characterized variously as "ochre clay" (*2*), "sandy shale" (*4*), "oolitic claystone" (*5*), "mudstone" (*6*), and "siltstone and claystone" (*7*), without mention of analcime. Laboratory examination by the writer, of the ocherous and oolitic mudstone, shows the dominant mineral constituent to be analcime, which is accompanied by fine angular quartz silt,

[1] University of Missouri Research Grants Nos. 410 and 415 are aiding in the field and laboratory work of this problem. J. D. Love kindly furnished locations of Popo Agie exposures unknown to the writer.

some carbonate, and pigmenting iron oxide. The accessory minerals are estimated to occur as less than 10% of some specimens and usually as less than 80% of most of the typical ocherous Popo Agie.

Recognition of the analcime is based on x-ray powder diffraction patterns, and its optical properties —namely, isotropic character and index of refraction which ranges slightly above 1.487. Loss of weight on ignition of the bulk specimen falls between 9 and 10% by weight.

White to slightly colored oolites represent the purest analcime in the Popo Agie, but it occurs also in the ochre-colored portions. The tiny spheres are definitely oolites (*4*), and are not euhedral to subhedral crystals, as were observed by Bradley (*1*) in the Green River, or by Ross (*8*) in the occurrence from Yavapai Co., Ariz. Ordinary bedding is absent in the analcime rock, but rectangular nodules up to 18 in. on an edge, which weather to well-rounded corners, and massiveness characterize its structure.

The origin of the Popo Agie analcime is tentatively postulated as representing an alteration or reaction product of colloidal clays with strongly saline water, whereby the sodium came from the water and the aluminum and silicon from the clay. In other words, analcime is believed to represent a stable hydrous sodium aluminum silicate in a saline environment, whereas illite might be the stable hydrous potassic aluminum silicate in a less saline marine environment. This origin is similar to the one proposed by Ross (*8*). Microscopic study of the Popo Agie so far has not shown the presence of significant feldspar, mica, shards, or other tuffaceous materials, which occur in the Green River and which are cited (*1*) as the most probable source of aluminum and silicon. It is possible that volcanic dust might still have contributed to the analcime, and that all nonquartz material has been entirely altered in the Popo Agie, leaving behind only fine-grained quartz silt, but there is no positive evidence for that.

The analcime-containing Popo Agie is quite widespread. It crops out in continuous exposure along the northeast flank of the Wind River Mountains. Five localities sampled between Derby Dome (15 miles southeast of Lander) to near Dubois, an airline distance on the northwest of about 70 miles, all show well-developed analcime. The analcime-bearing section on Middle Fork (Sinks Canyon) southwest of Lander is approximately 60 ft thick. Analcime is abundantly present also in the Popo Agie across the Wind River basin in Circle Ridge and Maverick Springs domes on the south flank of the Owl Creek Mountains. It was observed to the west in the faulted Popo Agie high on Red Rocks Cliff along the Gros Ventre River about 20 miles east of Moose, Wyo. Analcime was determined in oolitic ocherous Popo Agie well cuttings[2] at a depth of 4700 ft from Unit #1 Well, South Baxter basin, sec 21, T 16 N, R 104 W, south of Rock Springs, Wyo. Airline distance between the South Baxter basin and Circle Ridge Dome is approximately 150 miles across the Wind River range.

[2] Courtesy M. M. Fidlar, Mountain Fuel Supply Co., Rock Springs, Wyo.

Presumably the analcime rocks extended continuously across this area, or at least were formed throughout at about the same geologic time. They are unique mineralogically and should constitute a good stratigraphic marker. The base of the Popo Agie has not been defined previously (*2, 6*), but the lowest occurrence of analcime may be utilized as a reference surface for the base. The sediments overlying the analcime vary from conglomerate through sandstone to gypsum. The Triassic-Jurassic rocks of Wyoming are scant in index fossils, and the stratigraphy of the section has been controversial. The analcime rocks appear to be a single, definitely, and uniquely recognizable zone which may serve as a datum on which further stratigraphic conclusions may be based. The abundance and availability of the analcime make it worthy of consideration for possible technological use.

More detailed petrographic, chemical, and stratigraphic studies that are in progress will be published later.

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The Activation by Vitamin D of the Phosphorylation of Thiamin

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It appears that vitamin D is intimately linked with the metabolism of phosphorus in the living organism. There are several findings suggesting that the symptoms of rickets depend on changes in the metabolism of phosphorus. Zetterström (*1*) has demonstrated by *in vitro* experiments that phosphorylated vitamin D activates phosphatase obtained from various organs.

The amount of thiamin in food affects the blood and tissue concentration of cocarboxylase (*2*). If this vitamin is given intravenously or intramuscularly, the phosphorylation of thiamin to cocarboxylase proceeds rapidly. In 1951 we tried to determine whether vitamin D affects this synthesis. For the determination of the concentration of cocarboxylase in blood, the writers used the manometric method of Westenbrink (*3*). Alkali-washed yeast was prepared from dried yeast (obtained from Oranjeboom, Rotterdam). The analyses were made in duplicate. First a normal value for the cocarboxylase concentration in the blood of the experimental subjects was determined during 4 days.

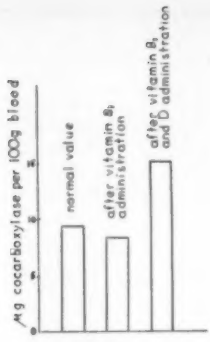

FIG. 1.

After this, the subject was given 0.05 g thiamin intramuscularly for 4 successive days, and finally 500,000 IU vitamin D and 0.05 g thiamin again for 4 successive days. The cocarboxylase concentration in the blood was determined throughout the course of the experiment. In some of the cases, vitamin D strongly activated the synthesis of cocarboxylase. Fig. 1 shows the

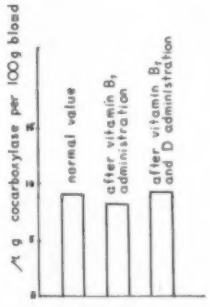

FIG. 2.

typical results of such an experiment. Younger subjects seemed less prone to this activation than older ones. In other cases, there was no activation (Fig. 2). This may have been due to the possibility of the subject's having been "saturated" with vitamin D before the experiment. In rickets, no activation was observed (Fig. 3).

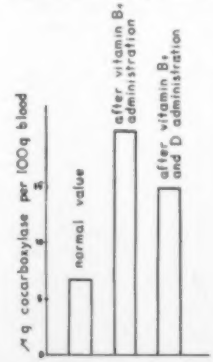

FIG. 3.

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Demonstration Concerning Pressure-Tension Relations in Various Organs

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Most textbooks of physiology used in medical schools in this country fail to make use of the formulas of Laplace relating the pressure in a hollow body, its radius of curvature, and the tension in its wall. This neglect has occasioned, for example, misleading theoretical treatments in hemodynamics. Some widely used books base a tendency of an aneurysmal sacculation "to go from bad to worse" on Bernoulli's hydrodynamic principle that along a line of flow in a tube the lateral pressure is increased in a dilated portion, where the velocity of flow is reduced. This, it is true, puts added strain on an arterial wall already weakened by disease processes. But no note is taken that the percentual increase in lateral pressure in such conditions must be quite small, as can be indicated by calculation or by demonstration in models. Actually, the *tension* in the dilated wall, which is the important consideration, tends to increase in proportion to the radius of curvature of the sacculation; and this is the dominant factor.

For a hollow sphere, Laplace's formula states $P = 2T/r$, where P is internal pressure (excess over external pressure), T is tangential tension in the wall, and r is the radius. For a cylinder the formula is $P = T/r$. Practically, the blood pressures in the aneurysm and in the portions of the vessel just proximal and distal to it may be essentially equal. If so, a sacculated segment with radius twice the proximal or distal segments would have to suffer a tension in its wall twice that of the wall of the proximal or distal vessel in order to sustain the pressure. Huge increases in tension may occur in the wall of greatly dilated vessels in which the change in blood pressure, following Bernoulli's theorem, is negligible.

Many students find it difficult to comprehend these pressure-tension relations in blood vessels. A model piezometer of glass or semirigid tubes is inadequate to suggest to an observer the state of tension in its walls. The demands on the imagination can often be obviated by an elementary demonstration in the classroom using a partially inflated tubular balloon (Fig. 1). It is easy for students to grasp the sense of Pascal's law

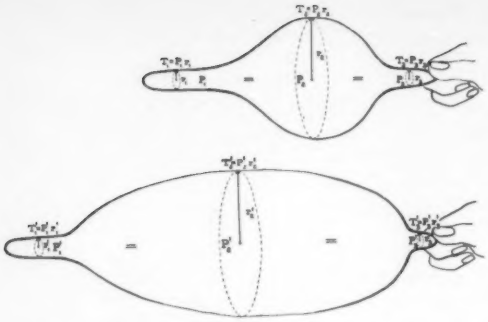

FIG. 1. Partially inflated rubber balloon may take these forms. The pressure P within the balloon is equally transmitted to all parts of the contained air (Pascal's law: $P_1 = P_2 = P_3$; $P_1' = P_2' = P_3'$), and the tension T in the wall of the balloon varies with the radius r in that portion.

that the pressure of the air within the balloon must everywhere be equal. The obvious tautness of the dilated portion (under greater stretch, with the rubber plainly thinner) contrasts sharply with the relative flaccidity of the undilated portion, making concrete the direct relation between the radius of curvature and the tension in the wall at a given internal pressure. It is demonstrated at once that this relation obtains even when there is no flow of fluid. One may note that this experiment is the converse of that performed in physics classes in which the air contained within each of two soap bubbles, blown on separate pipes, is put in communication. The surface tensions of the two soap films are essentially equal. Where one bubble has a smaller radius than the other, the internal pressure in that bubble is necessarily greater, and the small bubble discharges its air into the large.

Laplace's formula applies more exactly the smaller the wall thickness. In the case of a thin-walled cylinder (where the ratio of outside diameter to inside diameter is less than 1.20) one often considers only the "hoop stress" and assumes it to be uniformly distributed throughout the wall cross section. Hoop stress (e.g., in an iron pipe) drops off from a maximum value at the inner wall to a minimum value at the outer wall, the drop being greater the larger the ratio of diameters. Since, when a viscus is dilated, the cross-sectional thickness of the wall may markedly decrease, the tension of the wall per unit cross section is increased even more than indicated by Laplace's proportionality between radius and tension, applied to a relatively unstretchable wall.

Even without consideration of this aspect of the matter, the thinness of the walls of capillaries, for example, takes on added physiologic significance when considered in terms of wall tension rather than merely in terms of blood pressure. One becomes more sensible of how capillaries can sustain high blood pressures without rupturing (as where venous return is blocked), despite the delicacy of their structure. Burton *et al.* (*1–3*) have carefully studied the application of Laplace's equations in this field and reviewed much of the literature. Although these equations have long been known to physiology, few physiologists appear to use them in their everyday thinking and teaching. Classes will better understand such diverse physiologic topics as pressure-tension relations in the eyeball (*4*), the urinary bladder (*5*), the heart (*6*), and the gut (*7*) when proper attention is given to the formulas of Laplace. D'Arcy Thompson (*8*) treats of some of the more beautiful applications of these relations in biology.

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An Air-Cleaning Apparatus for the Flame Photometer

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We have found the flame photometer capable of measuring the sodium and potassium concentrations in biological materials with a precision comparable to that of the more laborious chemical methods. The simplicity and rapidity of the technique was, however, impaired by the extreme sensitivity of the instrument to room air contamination with dust and especially with tobacco smoke. In our instrument[1] the vaporized sample is led to the air inlet at the base of a Meker burner, where it is sucked with room air into the burner by the draft caused by the flame. An isolated or air-conditioned room was not available, and the photometer had to be used in a dusty room from which tobacco smoke could not always be excluded. Consequently the behavior of the instrument and the output were erratic, and much time was wasted in performing analyses under poor conditions because they had to be completed at once. To avoid the necessity of isolating the photometer or of air-conditioning the whole room, a closed air-cleaning system has been installed and has proved of value. The burner has been enclosed in an airtight chamber the inlet of which is through an air-cleaning apparatus and the outlet through a closed stack around the burner about 28 cm high.

In the Barclay instrument this was most easily

[1] A Barclay Flame Photometer, General Scientific Instrument Co., Hamden, Conn.

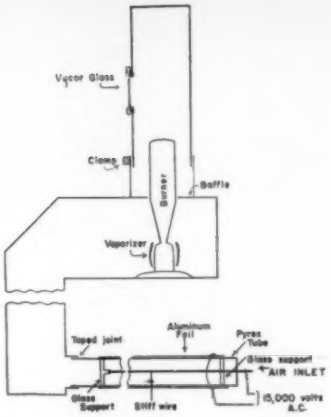

FIG. 1. Air cleaner attached to the inner, airtight chamber of the flame photometer.

achieved by constructing an inner chamber of sheet metal connected to a wide tube leading forward and downward just behind the control panel to the air-cleaning mechanism, the top of which was connected to the metal chimney provided in the machine. The windows in the chimney were closed with "Vycor" glass mounted in metal brackets.

The requisites for an air-cleaner with high efficiency and minimal obstruction to air flow, to eliminate the necessity of a forced air supply, are adequately met by a simple apparatus first suggested by Drinker (*1*). Such a precipitator, based on the principle of ionizing and precipitating foreign bodies in a strong electric field, has an air-cleaning efficiency of better than 98%. As used, it consists of two Pyrex tubes of 34 mm ID and 45 cm long, wrapped with aluminum foil and lacquered, with a stiff hay-binding wire mounted in the axis of each. A 15,000-v a-c source[2] is connected between the wire and the foil. Care must be used to provide protective shielding and insulation for the high-voltage circuit. This can be done most conveniently by placing the transformer near the tubes, thus shortening the high-voltage leads and enclosing the entire assembly in a wooden cage under the work-desk. In addition, the distance between the foil or center wire and the metal conduit must be at least 3 cm, to prevent sparking to the machine. Even with this distance the Pyrex tube and the glass wire support must be perfectly dry. The efficiency of the air-cleaning system can be judged from the absence of yellow flashes from the flame and from the appearance of the tubes after the apparatus has been working for some weeks: the distal 2″–3″ of the tube is coated with grime, the remainder perfectly clean.

The air chamber and precipitation tube interfere markedly with the free supply of air to the burner, even to the point where there is incomplete combustion of the propane, with the consequent appearance of zones of incandescence in the flame. This difficulty was overcome by building into the chimney a baffle plate (Fig. 1) which occludes the gap between the burner and the chimney, above the air holes in the former, deflecting through the burner air that would otherwise flow around it.

We have also found it necessary to decrease the width and height of the windows in the chimney through which light reaches the photocells; possibly because of a decrease in the width of the flame caused by the structural alterations we have made, the edge of the flame sometimes presented at one or another of the windows, leading to irregularities in the amount of light reaching the cells.

With these modifications, we have an instrument whose reliability and convenience are equal to those of the unmodified machine but which can be used without interruption, even in the presence of ordinary room air contaminants. The standard readings are reproducible for several hours, and the galvanometer is free of distracting fluctuation.

[2] A commercial neon light transformer of 15,000-v, 30-ma output is adequate for at least 3 such tubes connected in parallel.

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Manuscript received September 26, 1951.

A New Reaction and Color Test for Allethrin and Pyrethrins

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We wish to give a preliminary account of a new reaction and color test for allethrin and pyrethrins. Allethrin (*1*) is a synthetic insecticide of a structure similar to that of the pyrethrins and is used in insecticide sprays and aerosol bombs to replace the natural pyrethrins. Either pyrethrins or allethrin, but not pure allethrolone or chrysanthemum monocarboxylic acid, gives the reaction.

We have found that a solution of 2-(2-aminoethylamino) ethanol (Eastman's organic chemical, No. 4774, hydroxyethyl-ethylenediamine) in ethanol and alcoholic potassium hydroxide will give a red or violet color with pyrethrins or allethrin if sulfur is added. Without the addition of sulfur, allethrin does not give this color and pyrethrins appear to give only an orange color. The addition of sulfur to the pyrethrin orange reaction mixture causes a red or violet-brown color to form. Pure pyrethrins themselves may not react unless sulfur is present, but every supply available at present has reacted to give the orange color before the addition of sulfur.

The mechanism of the reaction is not known. It appears, however, that certain conditions must be met to cause the color reaction. Morpholine and other amines can take the place of 2-(2-aminoethylamino) ethanol and other alkalies can substitute for potassium

hydroxide, but sulfur, amine, alkali, and allethrin (or pyrethrins) must all be present for the color formation. The presence of ethanol aids the reaction. If sulfur is added as a solution in carbon tetrachloride, it is necessary to have a definite quantity present, since the addition of this solution dropwise causes a deeper and deeper color until a maximum is reached. Pure allethrolone, allethrolone semicarbazone, chrysanthemum monocarboxylic acid, and pyruvic aldehyde do not react under the conditions present. Impure allethrolone does give a red color even without sulfur. It is thought that this may be due to furan derivatives that may be formed in the cyclization process, since 2-methyl furan, furfural acetone, and furfuryl acetone give red colors without the addition of sulfur to the reaction mixture.

Under one set of conditions (without the addition of sulfur) 2 mg of natural pyrethrins gave a color reading of 35 in 12 min on the Klett-Summerson colorimeter, using the 44 filter. The same quantity of pyrethrins with sulfur present gave a reading of 277, and a like quantity of allethrin (with sulfur present), a reading of 269.

A number of substitutes for sulfur have been tried in the reaction. The addition of sodium sulfide to potassium hydroxide, ethanol, and 2-(2-aminoethylamino) ethanol gives a dull blue color that is not changed by the addition of allethrin. The addition of sulfur to this mixture causes the reaction to take place and a red-brown color to appear. Thiophene likewise cannot substitute for sulfur.

We have found the following reagent mixture satisfactory: To 25 ml 2-(2-aminoethylamino) ethanol we add 50 ml ethanolic potassium hydroxide (5 g 86% potassium hydroxide is dissolved in 100 ml ethanol and the faint cloud is filtered off through glass wool). To this mixture we add 425 ml ethanol and shake thoroughly to mix. If we add to 2 ml ethanol containing at least 2 mg allethrin or pyrethrins, 8 ml ethanol, 5 ml of the above reagent mixture and 10 mg sulfur, the color reaction occurs.

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Manuscript received October 15, 1951.

Spraying of Particulate Suspensions Containing Infective Materials for Electron Micrographic Analysis[1]

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Applications of a representative droplet field method (*1*) for examining particulate suspensions by electron microscopy have indicated its usefulness for the absolute assay of viruses (*2*) and for comparative studies on the composition of suitable preparations (*3*). A limitation of the method has been its inapplicability to the examination of pathogenic or noxious materials because of the production of an unconfined aerosol. A method has been devised that overcomes this limitation and at the same time permits the use of micro volumes of relatively dilute solutions. The method employs a self-contained apparatus of convenient size which, following an initial evacuation, can be maintained under reduced pressure during the entire operational sequence of introduction of several samples, spraying, and removal of exposed specimen grids. The sample volume needed for producing an adequate number of droplet patterns for observations over the limited scanning area of the universal model RCA electron microscope is about 10 λ.

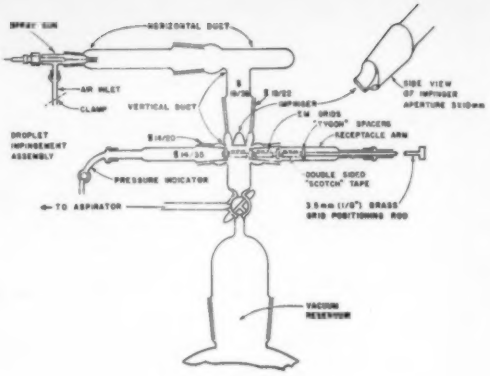

FIG. 1. Spray apparatus.

The device shown in Fig. 1 may be described in terms of three functional parts: (*a*) a 5-liter evacuated reservoir with a suitable valve for evacuation and regulation of the spraying unit, (*b*) a spray gun, and (*c*) an arrangement for droplet collection by impingement on specimen grids. In operation the apparatus is assembled and evacuated by water aspirator with the stopcock fully open. During evacuation the side arm of the spray gun remains clamped off, and the inlet end of the capillary insert is kept sealed (the sample inlet end of the capillary insert is flame-sealed during fabrication and severed to admit samples for spraying). On completion of evacuation the cock is turned through 180° and the pump connection removed. The apparatus may now be moved to a hooded area or to the vicinity of an autoclave if decontamination subsequent to spraying is contemplated.

The spray gun, shown in detail in Fig. 2, is designed to operate with the simultaneous admittance of liquid sample and air dispersant through their respective orifices into the reduced pressure area of the duct. The gun envelope orifice is made as small as practicable, since its size largely determines the rate at which the internal and external pressures equalize. In order

[1] This research has been supported in large part by a grant from the American Cancer Society upon recommendation of the Committee on Growth of the National Research Council.

[2] The author expresses his appreciation of the encouragement and counsel of Robley C. Williams of this laboratory.

to maintain as great a pressure difference throughout the sprayings as possible, entry of air through the gun is restricted by clamping the air inlet except when spraying.

An awareness of the characteristics of the spray gun is essential for securing good results. Because of unavoidable variation in dimensions of insert tips it has been found desirable to gauge the bore of each insert by examination with a calibrated $\times 20$ microscope as they are prepared. Although tips of finer bore than that indicated in Fig. 2 may be used, greater time is required for spraying to obtain adequate numbers of droplets, with a consequent dissipation of pressure differential. The rate of feed of sample material through the capillary while spraying should be about 1 λ/sec. A control preparation of indicator particles in the solvent used for the stock suspending medium should be sprayed. If this solvent control does not result in the production of "clean" droplets, a contamination of the droplets during formation, in flight, or on contact with the substrate may also be suspected.

Although provision is shown in the impingement assembly for collections of droplets on three sets of grids, six or more consecutive sprayings and collections may be done on one evacuation when using a 5-liter reservoir. The sets of electron microscope grids

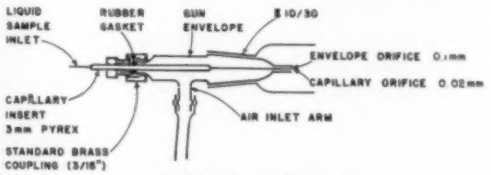

FIG. 2. Spray gun enlarged.

are carried in flattened recesses in the positioning rod between protective spacers cut from Tygon tubing as shown in the impingement assembly in Fig. 1. Scotch double-coated tape is used for holding the grids securely to the rod. After exposure to the spray, the grids are transferred for shadowing or for direct observation, with due regard for the infectiousness of the agents sprayed. The closely fitted spacers also serve to limit droplet impingement to those grids properly positioned across the duct. The impinger is constricted to an approximately 3×10 mm rectangular aperture to maximize the opportunity for droplets to strike the grids.

After spraying, the grids are removed in the following manner. The grids are retracted into the arm in which the positioning rod is mounted. With the gun air inlet open the stopcock is closed until the pressure indicator begins to inflate but remains partially collapsed, ensuring the continuance of a small negative pressure within the duct. The receptacle arm is disjointed from the assembly, and its contaminated end inserted into a protective tube. The opening in the duct resulting from removal of the arm is stoppered. If desirable, the gun may also be withdrawn and kept

FIG. 3. Droplet pattern.

intact while the rest of the apparatus is being decontaminated. Decontamination following the spraying of pathogens can be done by autoclaving or by inspirating an effective volatile disinfectant such as chlorine. A port in the apparatus should, of course, be cotton-plugged to admit steam when autoclaving.

The relationship of the lengths of the horizontal and vertical sections of the duct determines in part the ratio of the area of the droplet pattern in the microscope to the volume of the droplet as formed at the gun orifice, since the droplets are evaporating solvent en route to the grids. A relatively long horizontal section will permit the drying of larger droplets to a size that can be conveyed around the 90° bend into the vertical section. The length of the vertical section, including the impinger element, determines the extent to which the small droplets will be further reduced in size before impinging on the grids. If the vertical duct length is too great, permitting the complete drying of many droplets to their residues, the yield of droplet patterns will be too low for convenient observations to be made. The nonvolatile material left on complete drying of droplets in flight is seldom seen on the microscope grids, indicating that it is swept away from the grids by the air stream. Lengths of approximately 10 cm for both ducts have been found to give good results.

A droplet pattern of a suspension containing the particles associated with Q-fever—*Coxiella burnetii* (Derrick), Lederle antigen—mixed with polystyrene latex (PSL) (*1*) indicator particles is shown in Fig. 3. The number of PSL spheres, sprayed in a concentration of 7×10^8/ml with the *Coxiella*, indicates the volume of the droplet as formed at the gun orifice. The concentration of the organism may be calculated from the simple relationship:

$$\frac{\text{Organism count}}{\text{PSL count}} \times \text{PSL/ml} = \text{organisms/ml.}$$

Counts on a number of droplets must be made and the data examined statistically in order to establish the reliability of the techniques used in specimen preparation for each material studied. Individual patterns suitable for counting represent volumes of the order of 10^{-8} ml of original suspension. Since it is desirable for assay purposes to have at least 10 organism particles in each droplet pattern, it is apparent that an approximate minimum concentration of 10^9 organisms/ml is required. Inasmuch as a volume of only 10 λ is required for spraying, however, a total of 10^7 particles is sufficient for making a numerical assay.

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Schwarzschild-Villiger Effect in Microspectrophotometry

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Since Caspersson's pioneering work (*1*) in microspectrophotometry, this technique has yielded, especially in recent years, extensive applications in several modified forms (*2–4*), and has revealed many interesting problems in various fields of quantitative cytochemistry. The technique hitherto reported involves, however, a serious defect, which sometimes causes an error of large magnitude in the measured value of the light transmittance of a minute part of a cell nucleus, etc., thus leading to erroneous conclusions concerning the amount of its contents.

The defect in the usual measuring methods is that they are not free from the Schwarzschild-Villiger effect (*5, 6*). This effect, found by Schwarzschild and Villiger in 1906 in the microdensitometry of photographic plates, means that, in the measurement of the transmittance of a minute part of a photographic plate, the measured value would be unduly and sometimes seriously enhanced whenever the illuminating light flux is not limited to the part on the plate. The origin of the effect is readily conceivable. When the illuminating flux is spread over a wide area, including the minute part in question, the light passing through the surrounding portion may cause flare light, owing mainly to the internal reflections and scattering of the light in the image-forming optical system; and the flare light, being added to the image of the part in question, enhances the value of the measured transmittance. Thus the effect is especially prevalent when the transmittance of the part is low and that of its surroundings high, as in the case of the microdensitometry of the photographic image of a star or a spectral line. The circumstances are the same in microspectrophotometry, and the effect is serious in the case of a deeply stained cell nucleus embedded in a transparent background.

The main part of the flare light is caused by the internal reflections of light at each air-to-glass surface of the photomicrographic system, and the effect can readily be estimated quantitatively. If a light flux of one unit enters the lens system composed of m air-to-glass surfaces, all having the same average reflectance $\bar{r}$, the part $(1-\bar{r})/\{1+(m-1)\bar{r}\}$ of the flux is transmitted, of which the part $(1-\bar{r})^m$ is utilized for imagery, the effect of light scattering and absorption being neglected. Thus the ratio θ of the flare flux to the total transmitted flux is given by

$$\theta = \left\{\frac{1-\bar{r}}{1+(m-1)\bar{r}} - (1-\bar{r})^m\right\} \Big/ \frac{1-\bar{r}}{1+(m-1)\bar{r}},$$

which is the same as the ratio of intensity of illumination of the flare light (due to internal reflections only) on the image plane to the actual intensity of illumination on the same plane, provided the brightness of the object is uniform and its dimensions are sufficiently large—i.e., comparable with the effective focal length of the image-forming system. The values of θ for various values of m are shown in Table 1, for $\bar{r}=0.05$

TABLE 1

m	θ (%) for $\bar{r}=0.05$	θ (%) for $\bar{r}=0.01$
1	0.00	0.00
2	0.25	.01
3	0.72	.03
4	1.40	.06
5	2.26	.10
6	3.27	.14
7	4.44	.20
8	5.73	.27
9	7.12	.35
10	8.62	.43
11	10.20	.52
12	11.84	.62
13	13.54	.72
14	15.29	.84
15	17.09	0.97

(for all usual optical systems) and $\bar{r}=0.01$ (for coated optical systems).

If the number m of the photomicrographic system from the specimens to the image plane is 13, as is the case in our system—namely, 7 in an oil-immersed objective ($f=1.8$–2 mm), 4 in a Huygenian eyepiece, and 2 in a reflection prism—and if the specimen is illuminated by a beam of light several millimeters wide, then the flare light caused by internal reflections only amounts to *ca* 13.5%, and the transmittance of a deeply stained nucleus having the true transmittance

[1] The author wishes to extend his sincere thanks again to Z. Koana, of our department, who has demonstrated the influence of the Schwarzschild-Villiger effect in microspectrophotometry and guided him throughout the photometric work, and to A. Sibatani, of the Institute for Microbial Diseases, University of Osaka, for the preparation of the microscopic specimens.

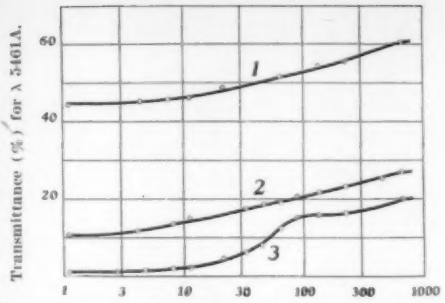

FIG. 1. 1—Isolated nucleus of rat liver (diam, 6.2 μ); 2—isolated nucleus of rat liver (diam, 4.4 μ); 3—first spermatocyte of rat testis (diam, 5.5 μ).

of, say, 1.0% must be measured as 14.5%, which is fourteen times as large as the true value. Thus the error in the value of the transmittance is 1350%!

The error is further enhanced by the flare light because of the scattering of light at lens surfaces that are not perfectly polished or are contaminated, or contain minute bubbles. These flares cannot be evaluated by simple mathematical treatment, but it is certain that their effect is more serious in lenses of smaller dimensions, as in microscopic objectives of high magnifying power.

In order to verify the above statement and to get the true value of the transmittance, we have performed the following experiment upon cell nuclei of spherical form, 4 μ–6 μ in diameter, and differing in their transmittance of light.

The magnified image of the specimen (×2000) is formed at the image plane of a photomicrographic system, and a fixed diaphragm of 2 mm diameter, placed at the image plane, leads the light corresponding to the small part of the specimen 1 μ in diameter to a photomultiplier tube. The illuminating system under the specimen forms the image of a uniformly luminous iris diaphragm at the center of the specimen, the diameter of the image being variable from 1 μ to 650 μ. For smaller imagery an oil-immersed microscope objective is used as a condensing lens, as described in our previous report (*7*). The transmittances of each of the three specimens were measured by this apparatus, and in each case the diameter of the illuminated area was varied from 1 μ to 650 μ. The results are shown in Fig. 1. In cases of small illuminated areas, the measured transmittances of the specimens become constants which must be considered to be the real transmittances of the nuclei. When the illuminated area is broadened, the measured values show a gradual increase, but they tend to a constant saturated value, which must be the sum of the true value and the flare light discussed above. Although the maximum diameter 650 μ in our experiment is not sufficient to cause the fully saturated flare, the enhanced value exceeds the flare ratio shown in Table 1, where we can attribute the difference to the flare caused by the scattering of light. The irregularity in the curve for specimen No. 3 can be explained as the effect of other nuclei existing in the same field, as shown in Fig. 2.

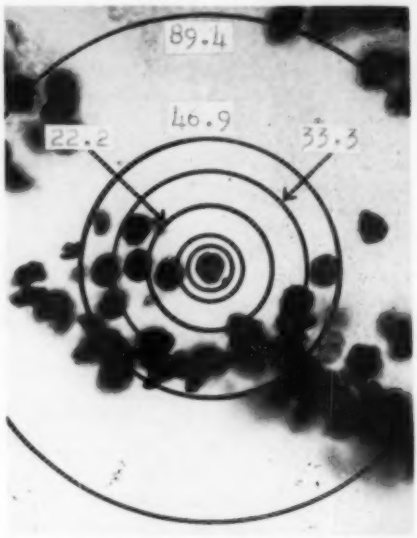

FIG. 2. Nucleus at center of circles is specimen No. 3. Number attached to each circle indicates its diameter in μ.

These results indicate that the true value of the transmittance can be measured only when the diameter of the illuminated area is less than (preferably one third) the diameter of the nucleus.

The Schwarzschild-Villiger effect can be reduced by antireflection treatment of all air-to-glass surfaces of the lens system. If we assume that the value of r be reduced to 0.01 by the coating and that no scattering of light occurs at these surfaces, the flare ratio θ, as shown in the last column of Table 1, amounts to only 0.72% in our system, which means 72% error in the example mentioned above, where the actual transmittance is 1.0%. The effect can be further reduced by using an all-reflection type microscope objective instead of the ordinary refraction type, in combination with a coated eyepiece. However, the scattering of light at each surface is not negligible in the measurement of low transmittance, so that the need for a small illuminated area can never be neglected, even after the improvements in the apparatus just proposed.

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Comments and Communications

International Organization of Scientific Documentation Based on Legislation

HAVING worked for some years on geological and especially paleontological subjects, I have, like many other researchers, come up against the ever-growing difficulties of documentation and have been forced to the conclusion that really serious paleontological work is almost impossible because workers are not able to get all the necessary documentation on the subjects that interest them. A serious consequence is that the best of them too often desert, or at least their research flags; and the *arrivistes* or the *mediocres* acquire the habit of publishing on subjects for which they are aware that they have not consulted the necessary references. Attempts to correct this situation have nearly all failed owing to the individualism or the *chauvinisme,* mostly unconscious, of the organizers, or to insufficient financial resources.

In France, however, one must not neglect the work undertaken by the CNRS in its *Bulletin analytique* and by Dr. Roger in the Geology Branch of the Paris Muséum National d'Histoire Naturelle, in his Centre d'Etudes et de Documentation Paléontologique (CEDP), where nearly all the articles reaching Paris on the earth sciences are recorded on cards and analyzed.

The basis of modern documentation is the annotated, analytical card file, and from what we know of the present status of documentation we may conclude that (1) dozens, possibly hundreds, of people are preparing cards of the same works and are thus engaged in useless duplication of labor; (2) useful scientific documentation, in every field, is growing in volume and is acquiring more and more an international character; (3) the present system of analysis implies that every worker or research organization must pay the cost, not only of documenting the references that are of interest but also of many others; (4) no national or private enterprise for documentation has as yet been able to remedy this waste of time and money, and it is doubtful whether any general agreement to correct the situation will succeed; (5) the time now consumed in duplicate documentation could be much more usefully devoted to the systematic classification of documentative cards by subjects of interest; (6) in general authors of articles are the ones best equipped to prepare summaries of them.

The present situation, which is steadily becoming worse, is so critical that the following remedial measures may profitably be considered:

1) Steps would be taken by Unesco to secure the adoption of a law in all the countries of the world (a law alone being susceptible of being followed in spite of neglects or nonenforcement) prescribing:

a) That all articles printed in a country be allowed to circulate only if they are accompanied by cards of standard size giving all the pertinent references, and cards giving an analytical abstract—one in the author's mother tongue, the other in the language most in use or allowing the most rational and precise expression of facts and ideas (tongue to be chosen by an international congress);

b) That separate reprints of these cards be issued in sufficient quantity and sent to a national or international agency for exchange in a prescribed manner, so that in every country a state organization may provide all the main research centers with all the cards of interest to them for a cross-indexed card file. This organization should also provide, at cost, every individual researcher with the cards he may want. The staff previously employed to prepare cards or abstracts might then be set to work on a systematic classification of material so as to provide every worker with all the documentation concerning research on a given subject.

2) An international scheme for the documentation of material published prior to the application of the law should be established. It is suggested that each nation prepare an inventory of its own publications and assign the task systematically to existing organizations (libraries, laboratories, etc.) for as rapid completion as facilities may permit.

3) To finance the national and international agencies created in consequence of the application of the proposed laws and agreements, the transfer and consolidation of many existing agencies should suffice for the most part.

4) For control an advisory commission should be established, comprising delegates of scientific organizations from the various countries and specialists in documentation. This commission would form a sort of international scientific council on documentation.

Assuming the question of the card file and abstracts to have been resolved in the manner outlined, a second difficulty, as yet practically and statistically unsolved, is the question of the languages into which the cards will be translated for international distribution. Even if a researcher has been able to provide himself with all the cards concerning the subject he is working on, he must still understand the references. The adoption of a universal language for abstracts is one possibility. In any event, the cost of translation, even by a specialized agency, will be prohibitive. It seems that only one possible practical solution may be considered: training of specialized translators (for instance "French, Spanish, Italian" or "Slav languages," etc.) with a sufficient scientific specialty education, and an opportunity for the specialized researchers to confer directly with the translators.

In many countries the efficient pursuit of research will soon become impossible under present conditions owing to the ever-growing difficulty of documentation and in spite of increasing specialization of the sciences. The remedies proposed here are the training of translators with specialized scientific information who

would be available for oral consultation; the systematic and periodic publication of up-to-date compilations dealing with each branch of research; and the creation through Unesco of an international organization for the preparation of card files based on the application in every country of laws prescribing the printing of abstract cards at the same time the work is published. It will require some legal compulsion to overcome inertia, nationalism, individualism, and competition, and thus promote the most rapid advance of research on an international scale.

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Vitality of the Aged

THE writer presented statistical evidence in 1929 (SCIENCE, 70, 85) of a persistent retrogression in vitality among the aged of both males and females of this country—in marked contrast with the distinct improvement at all earlier ages. Similar results were obtained by others, and this retrogression was reported to be generally accepted by the representatives at the recent International Gerontological Congress at St. Louis.

The writer now wishes to present evidence based upon succeeding years of a surprising improvement at these advanced ages. This report is brief and preliminary because we still await an analysis of the data from the 1950 U. S. census for further assurance that improvement has come to stay.

Table 1 gives the death rates (per 10,000) at ages 70 and 80 for both males and females for the earlier decennial years, as well as for the later years 1930 and 1940.

TABLE 1
DEATH RATES (PER 10,000)

Year	Males (age)		Females (age)	
	70	80	70	80
1890*	556	1227	502	1127
1900	606	1323	549	1206
1910	630	1387	569	1259
1920	605	1319	568	1225
1930	600	1309	517	1188
1940	599	1290	469	1138

* Seven states.

It should be noted that the maximum rates seem to have been reached sometime between 1910 and 1920 for both males and females, and that the rates have now fallen to about what they were at the beginning of the century, when official records of deaths began. The females enjoy lower rates throughout.

The rates tabulated in Table 1 apply only to the ten original registration states (the six New England states, and Indiana, Michigan, New Jersey, and New York), which were the only states to supply official mortality data from the beginning of the century, and were computed by a technique used in constructing abridged mortality tables.

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Applications of Ecology and Economics to Fisheries

NEWCOMBE (SCIENCE, 114, 27 [1951]) holds up halibut management as a model to the California pilchard industry and says that pilchard investigators "were quite well aware that a major catastrophe was imminent because the *catch per unit of effort* was on the decline, even though total catches continued to increase. . . . Numerous warnings were issued by the Division of Fish and Game as early as 1930, but, seemingly, research evidence was in itself insufficient proof."

This is naïve, to say the least. Sette (in a profound and authoritative paper included in Newcombe's list of references) was of the opinion in 1943 that "at the present stage of research on the pilchard population, we do not have any notion" what fishing intensity would be desirable, and this evidently is still true. The same may be said of halibut (Burkenroad. *Bull. Bingham Oceanog. Coll.*, 9, [4], 81 [1948]; *Texas J. Sci.*, 2, 438 [1950]; *Bull. Inst. Marine Sci., Univ. Texas*, 2, 1 [1951], which extends the discussion to general principles).

The disaster that overtook the pilchard fishery in the late 1940s was evidently connected with unfavorable natural changes. Newcombe's view that the occurrence could have been "averted" by fishery restrictions thus implies belief that, if the catch had been smaller, the recruitment, growth, natural survival, and/or availability would have been greater. Otherwise he must mean merely that, if the marketable catch had been sacrificed to permit more of the fish that came into range of the fishery to remain in the water, some of these might for a time have been included in subsequent catches to cushion the effects of shrinking renewals on raw-material costs.

However, Newcombe cites no evidence that the pilchard stock has been driven below its level for maximum equilibrium yield. It has to be borne in mind that events accompanying and following the temporary obliteration of a number of great fisheries for clupeids (e.g., for Gulf of Maine menhaden in the nineteenth century, and for herring in one or another Swedish area during the thousand years of record) do not suggest that these local changes in abundance could have been significantly affected by any human act.

It remains to be seen whether even the present immense expansion of the pilchard research program can furnish proof that restrictions would have procured (or are now procuring) a net gain to society through effort saved without countervailing sacrifice of catch. The summary by McHugh and Ahlstrom (*Sci. Monthly*, 72, 377 [1951]) is hardly encouraging.

For example, if distinction still cannot be made between natural mortality and availability of adults (p. 381), how is it possible to distinguish between recruitment and availability in attributing the decline in catch per unit effort in 1935–38 to "rapidly increasing fishing pressure" (p. 378)?

In any case, a better appreciation of the formidable nature of the equations of biological and social equilibria that are to be written and solved deductively is important. Elementary misconceptions, like Newcombe's and the conversely used but comparable ones of Taylor (*Survey of Marine Fisheries of North Carolina,* Chapel Hill: Univ. North Carolina Press [1951]) impede administrative realization that biologically effectual and socially advantageous restriction of some sea fisheries is theoretically indicated to be feasible, but that reliable results at reasonable costs can as yet hardly be expected in practice without use of the *inductive* method. Inductions permitted by the accidents of wars have led to a relatively assured resolution of the problem of effects of North Sea trawling on production costs. The method could be made a regular tool of fishery investigation through design of regulations in forms equivalent to *controlled* experiment, a procedure that would often be practicable if thinking about fishery situations were more careful.

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THE subject of Burkenroad's letter is a symposium paper entitled "The Application of Ecological Research to Aquiculture and the Fisheries." This paper includes, for purpose of illustration, a "review [of] events in the development of this [the sardine] fishery" based upon certain findings and opinions of Pacific coast fishery biologists. Burkenroad takes exception to some of their interpretations and explanations of known fluctuations in fish populations.

In the symposium article, hope is expressed "that, when the full story is written, it will prove to be an analog of the halibut fishery of the North Pacific Coast developed so skillfully under the leadership of W. F. Thompson." The article clearly indicates in what respects the two fisheries may be considered to correspond—namely, they both present a major challenge to administrators, biologists, and fishermen alike; they are both intrinsically ecological problems; and they both present an example of unified, balanced, cooperative effort in scientific fishery management.

What disturbs Burkenroad most is the reference to assumptions based upon the *catch per unit of effort.* Although it is impossible, in a short communication, to discuss all the varied ramifications of this oft-debated subject, opinions of several long-time students of fishery biology may properly be indicated. Scofield (*Calif. Fish & Game,* **24,** (3), 219 [1938]) states "The *catch per unit of fishing effort* is significant and is one of the best ways of measuring abundance in the ocean." Taylor, in a 1951 book entitled *Survey of Marine Fisheries of North Carolina,* described by one reviewer (Thompson, E. F. *Ecology,* **32,** (3), 566 [1951]) as an "analysis [that] should provoke much needed clear thinking in the muddled theory of fishery management," states (p. 135) that "the best indication of an over-fished population is in a decrease in catch-per-unit-of-effort." Also, the 1948 *Bulletin I* of the Pacific Marine Fisheries Commission points out (p. 53) that "The biologists of the three states [California, Oregon, and Washington] agree in the interpretation that heavy fishing intensity and poor spawning survival have reduced the population [of sardines] to a dangerously low level and that management of the fishery should not be postponed."

Burkenroad quotes Sette's 1943 statement that, as of that date, "we do not have any notion" what fishing intensity of sardines would be desirable, and states that it "evidently is" true in 1951. In August 1948, however, the research staffs of California, Oregon, and Washington recommended "an annual bag limit of sardines, initially of not more than 100,000 tons and preferably of 50,000 tons" (*Bull. Pacific Marine Fisheries Com.,* **1,** 53 [1948]). It seems reasonable to assume that such a recommendation would be based on a substantial amount of data, recognizing, of course, that subsequent data might well warrant a modification of this recommendation. Significantly, according to the 1950 *Progress Report of the California Cooperative Sardine Research Program* (p. 8), "The Division of Fish and Game has accumulated almost half a million individual observations on the size of sardines." This mass of records, together with the well-known, exemplary system for collecting and compiling fishery statistics employed at the Division's Terminal Island Laboratory, provides ample basis for assuming an official recommendation to be based on the best available fishery data and seasoned judgment.

Burkenroad also takes apparent exception to the halibut findings of W. F. Thompson and his collaborators, although the record suggests that, even in comparatively recent years, he may have entertained some reservations on this particular viewpoint. Thus, in a 1948 *Bulletin of the Bingham Oceanographic Collection* (**11,** (4), 62, 63), Burkenroad states

> It has been generally considered that the Pacific halibut affords a clear and proven case both of serious reduction of a population of marine fishes by fishing and of the subsequent rehabilitation of the population through restriction of exploitation. [Continuing, he states that the purpose of his paper is] to demonstrate that . . . the magnificent studies published by Thompson and his collaborators are insufficient to exclude the possibility that natural fluctuation has been the major factor in the long-time decline and recovery in abundance of at least one of the stocks.

Despite being somewhat limited in scope, this interesting and searching paper of Burkenroad's constitutes an exceedingly valuable contribution; but, like Thompson's monumental work, it will not find universal acceptance. In fact, Burkenroad (p. 127) generously admits "I am perhaps prejudiced in favor of the view that natural fluctuation may be the cause of

most of the changes in our fisheries because this proved to be the case in my first effort in the field of population study."

In the case of marine fisheries for species that have a high reproductive potential, such as the sardine, environment may properly be assigned a relatively important role, if not a dominant one, in designating the possible factors that determine numerical population changes. Supporting this side of the debate, Merriman concludes (*Sci. Monthly*, **68**, 13 [1949]) ". . . in fisheries with large numbers of eggs the fluctuations in abundance are likely to be due more to the environment than to the size of the adult stock."

The symposium review article does not overlook the importance of ecological factors in their relation to natural fluctuations. Quite the contrary, it points out (p. 2) that "Knowledge of how the ecological factors of the marine environment influence the size and composition of the catch is quite as important as an understanding of how fishing intensity affects the population," and again (p. 4) that "In the ocean, interest centers on the effect environment exerts on population numbers." Here, we are clearly in agreement. In fact, from what I am able to glean from Burkenroad's communication, we may be more in agreement than in disagreement. Obviously, one should hesitate to jettison, arbitrarily and without comparable supporting record, the findings and hypotheses of some of the most widely experienced fishery investigators—such as Thompson and Taylor—much less to relegate a serious consideration of their contributions to the realm of naïveté.

CURTIS L. NEWCOMBE

Hidden Valley
Lafayette, California

Erratum

In the article entitled "The Use of an Ion Exchange Resin for the Hydrolysis of Casein and Coffee Proteins" (SCIENCE, 115, 95 [1952]), we have inadvertently omitted glycine 4.53 and 4.38 mg of nitrogen for the HCl and resin hydrolysates, respectively, in Table 1.—G. E. UNDERWOOD and F. E. DEATHERAGE.

Book Reviews

Biochemistry and Physiology of Protozoa, Vol. I. André Lwoff, Ed. New York: Academic Press, 1951. 434 pp. $8.80.

In the introduction the editor states, "For the future development of protozoan biochemistry, it seems of utmost importance that an atmosphere develop in which more biochemists may feel, without external pressure, that many problems of the biochemistry of Protozoa are now ripe for further investigations. . . ." The book aids in creating such an atmosphere.

A section on phytoflagellates by S. H. Hutner and L. Provasoli discusses, with extensive references, the comparative biochemistry and photosynthesis, including suggestions for demonstrating in phytoflagellates types of photosynthesis similar to those found among bacteria, and for testing postulated first products of photosynthesis by supplying them as nutrients to obligate phototrophs; evolution and biochemistry of photoreceptors; biochemistry of "acetate" flagellates; induction of apochlorosis with streptomycin; vitamin requirements, with particular reference to B_{12} nutrition and assays of bound vitamins using phagotrophs; mineral requirements and chelating agents for mineral buffering; and sexuality in *Chlamydomonas*. Many speculative ideas are developed that should stimulate experimental investigation.

In "The Nutrition of Parasitic Flagellates (Trypanosomidae, Trichomonadinae)," M. Lwoff reviews the requirements of trypanosomes for hematin and the evidence that ascorbic acid is an essential growth factor. The effect of changes in chemical configuration on thiamin activity is of particular interest. The anaerobic nature and the sugar fermentation of *Trichomonas* are described. Cailleau's detailed work on the cholesterol requirement of *T. columbae* is reviewed, including the experiments on the influence of chemical configuration on activity. These experiments constitute some of the most convincing evidence that protozoa may contribute notably to biochemistry.

Von Brand's extensive researches on the metabolism of parasites qualify him for the authoritative discussion of the "Metabolism of Trypanosomidae and Bodonidae." The high oxygen consumption of certain trypanosomes and its variation with developmental state are described. The carbohydrates fermented and their fermentation products are given, and fat and protein metabolism is briefly reviewed. The mechanism of host injury and the action of drugs on trypanosomes are discussed in detail.

A short chapter on the "Nutrition of Parasitic Amebae" by M. Lwoff emphasizes the oxidation-reduction potential and the requirement for cholesterol.

In "Biochemistry of *Plasmodium* and the Influence of Antimalarials," R. W. McKee discusses the blood changes accompanying infection, *in vivo* and *in vitro* nutrition, metabolism, natural immunity, and antimalarials. Investigations in this field have proceeded so rapidly since the war that this organization of results is particularly appropriate.

The section on "Biochemistry of Ciliates in Pure Culture" deals chiefly with *Tetrahymena*, the most studied ciliate. G. W. Kidder and Virginia Dewey, themselves active contributors in the field, have pro-

vided a detailed account of the nutrition and metabolism of pure cultures of ciliates. The complexities in the nutrition of these "simple" animals, and the few species that have been pure-cultured, constitute a challenge to biologists and biochemists.

The entire volume, with its repeated emphasis on comparative biochemistry and physiology, should prove stimulating not only to protozoologists but to biologists and biochemists generally. It is quite clear that the "little animals" present many intriguing problems.

R. E. HUNGATE
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State College of Washington

The Vitamin B Complex. F. A. Robinson. New York: Wiley, 1951. 688 pp. $9.00.

Knowledge of the individual compounds that comprise the vitamin B complex, and of their significance in nutrition and metabolism, has grown tremendously in recent years. Despite this fact, and the difficulties in orientation that it entails for the newcomer to the field, no up-to-date monographic treatment has been available until recently. This book was written to fill the gap; in the meantime, another monographic treatment of the same field has appeared (Williams *et al. The Biochemistry of B Vitamins,* Reinhold [1950]).

The present book treats each of the B vitamins (thiamin, riboflavin, niacin, vitamin B_6, pantothenic acid, biotin, folic acid, vitamin B_{12}, *p*-aminobenzoic acid, inositol) in a separate chapter, each organized under 6–22 subheadings. These include topics such as history, isolation, synthesis, properties, stability, methods for determination (chemical, biological, and microbiological), distribution in foodstuffs, effect of deficiencies in man and animals, effects on microorganisms, metabolism, analogs, etc. Bibliographic references are given at the end of each of the subsections, a practice that increases the ease of referring to them. This tends to create a discontinuity in the text, however, and frequently necessitates several printings of the same reference at different places in a single chapter. Good author and subject indexes are provided.

The diversity of the topics covered, and the large number of original papers surveyed, preclude an intimate knowledge of each topic by a single author; consequently, it is not surprising to find a considerable number of factual and interpretative errors in the text. Some of these, but by no means all, result from an uncritical acceptance of claims made in the original literature, but later corrected. For example:

N. sitophila can utilize pyridoxal, pyridoxamine, or pyridoxine with equal facility in satisfying its vitamin B_6 requirement, despite the statement (p. 313) that it utilizes only pyridoxine. Similarly, *Streptococcus faecalis* R and *Leuconostoc mesenteroides* P-60 grow without added riboflavin, despite the statement (p. 204) to the contrary. The reported growth and antianemic properties of α- and β-pyracin, emphasized at several points in the text (pp. 320, 336, 344, 459), have never been confirmed, despite repeated attempts. Few nutritionists now believe that pernicious anemia is due to inability to utilize folic acid conjugates, or that vitamin B_{12} is specifically required for the cleavage of such conjugates (p. 526). An inconsistency in nomenclature, which has the sanction of common usage but is nonetheless confusing and misleading, is continued in this book—namely, frequent use of the term *pyridoxine* as a name both for the specific compound, 2-methyl-3-hydroxy-4,5-bis(hydroxymethyl) pyridine, and as a term synonymous with vitamin B_6, and hence including the forms pyridoxal and pyridoxamine. One must judge from the context whether the specific or general sense is meant. Considerable space is devoted to chemistry of α-biotin. Most investigators in the field will feel that the existence of this substance as a distinct entity from synthetic biotin (β-biotin) remains to be proved.

Quantitative relationships are occasionally overlooked. Thus, the claim that *p*-aminobenzoic acid is required in the diet of trout is reported without comment (p. 552), despite the fact that the amounts reported as necessary (10–20 mg/100 g of diet) could scarcely be obtained by ingestion of any assortment of natural foodstuffs, if the data for distribution of this compound, reported elsewhere in the text, are correct. In general, the coverage of individual topics is quite complete to the date of printing. A notable exception is the treatment of distribution of the vitamins, where only illustrative values appear to be given, and little attempt is made to arrive at the most reliable estimates of potency in terms of present-day knowledge of assay techniques, extraction procedures, etc.

Individually, errors or drawbacks such as those illustrated above are perhaps of little importance; collectively they seriously lessen the usefulness of the monograph as a source of authoritative information. Nonetheless, the book contains a large amount of well-organized and generally reliable information that has not been summarized elsewhere. It is well printed and extensively documented. It thus provides a useful addition to the literature on vitamins, and one that merits extensive use.

ESMOND E. SNELL
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University of Texas

Scientific Book Register

Textbook of Electrochemistry, Vol. I. Rev. ed. of *Lehrbuch der Elektrochemie.* G. Kortüm and J. O'M. Bockris. Houston–Amsterdam: Elsevier Press, 1951. 351 pp. $7.00.

The Anthropology of Iraq: The Northern Jazira, Part II, No. 1. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol. XLVI, No. 1. Henry Field. Cambridge, Mass.: Peabody Museum, Harvard University, 1951. 116 pp., tables and plates. $6.50.

Antibiotic Therapy. Henry Welch and Charles N. Lewis. Washington, D. C.: Arundel Press, 1951. 562 pp. $10.00.

Stages in the Evolution of Plant Species. Jens Clausen. Ithaca, N. Y.: Cornell Univ. Press, 1951. 206 pp. $3.75.

Internal Constitution of the Earth. Rev. 2nd ed. Beno Gutenberg, Ed. New York: Dover, 1951. 439 pp. $5.50.

Meetings & Conferences

Feb. 27–Apr. 21. Festival of Contemporary Arts (Annual). University of Illinois, Urbana and Champaign.

Mar. 1, Mar 5. Institute of General Semantics, Alfred Korzybski Lectures (Annual). Waldorf-Astoria Hotel, New York.

Mar. 11–12. National Farm Chemurgic Council (Annual). Statler Hotel, St. Louis.

Mar. 17–19. Aero Medical Association (Annual). Statler Hotel, Washington, D. C.

Mar. 17–19. Midwestern Conference on Fluid Mechanics. Ohio State University, Columbus.

Mar. 17–21. American Society of Tool Engineers. Industrial Exposition. Chicago International Amphitheatre, Chicago.

Mar. 19–21. American Association of Anatomists (Annual). Brown University, Providence, R. I.

Mar. 20–22. American Physical Society. Deshler-Wallick Hotel, Columbus, Ohio.

Mar. 24–27. American Association of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, Society of Exploration Geophysicists (Joint Annual). Biltmore Hotel, Los Angeles.

Mar. 24–27. American Chemical Society. Buffalo, N. Y.

Mar. 24–27. American Mosquito Control Association (Annual). Salt Lake City.

Mar. 26–28. American Power Conference (Annual). Sherman Hotel, Chicago.

Mar. 27–28. American Association of Economic Entomologists, North Central States Branch. St. Paul Hotel, St. Paul, Minn.

Mar. 27–29. Empire Association of Medical Technologists (Annual). Hotel Syracuse, Syracuse, N. Y.

Mar. 28–29. American Association of University Professors (Annual). Bellevue-Stratford Hotel, Philadelphia.

Mar. 28–29. Eastern Psychological Association. Chalfonte-Haddon Hall, Atlantic City.

Mar. 29–30. American Psychosomatic Society (Annual). Chicago.

Mar. 31–Apr. 3. American Chemical Society. Milwaukee, Wis.

Mar. 31–Apr. 4. American Congress on Obstetrics and Gynecology. Netherland Plaza Hotel, Cincinnati.

Mar. 31–Apr. 4. Symposium on the Suprarenal Cortex. Colston Research Society. Bristol, Eng.

Apr. 4–5. National Aviation Education Council. Cooley Plaza Hotel, Boston.

Apr. 5. Association for Research in Ophthalmology, Midwestern Section (Annual). Indiana University Medical Center, Indianapolis.

Apr. 5–6. Eastern Sociological Society (Annual). Haverford College, Haverford, Pa.

Apr. 5–9. American Association of School Administrators (Regional). Boston.

Apr. 6–9. American College of Allergists (Annual). William Penn Hotel, Pittsburgh.

Apr. 6–9. National Agricultural Chemicals Association. Fairmont Hotel, San Francisco.

Apr. 7–8. Histochemical Society. Hotel New Yorker, New York.

Apr. 7–9. Seminar on International Wool Research Project. Lowell Textile Institute, Lowell, Mass.

Apr. 8–10. Faraday Society Discussion. Leeds, Yorkshire, Eng.

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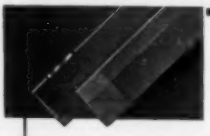

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